MEXICAN-AMERICAN ADOLESCENTS AND METABOLIC SYNDROME: DECIPHERING THE ROLE OF ACCULTURATION

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ABSTRACT

RAFAEL ENRIQUE RUIZ: Mexican-American Adolescents and Metabolic Syndrome: Deciphering the Role of Acculturation
(Under the direction of Deborah E. Bender)

Metabolic syndrome (defined by three or more of the following traits: elevated triglycerides, low HDL, abdominal overweight, elevated fasting plasma glucose, and elevated blood pressure) has been linked to an increased risk of type-2 diabetes and cardiovascular disease. Cook and colleagues (2003) demonstrated that Mexican American have the highest prevalence of metabolic syndrome among adolescents. Thus, understanding the factors associated with an elevated risk for metabolic syndrome in this population is paramount.

This study examines the role of acculturation on the risk of metabolic syndrome and its antecedents, physical activity and dietary intake, in Mexican-American adolescents. A pooled cross-section (N=1831) of adolescents (12-19 yrs.) was taken from the NHANES 1999-2002. Logistic and linear regression models were used to examine the relationships between acculturation and metabolic syndrome, physical activity, and dietary intake controlling for other known correlates.

The overall prevalence of metabolic syndrome was 4.8% or approximately 1.5 million U.S. adolescents. Mexican American ethnicity, overweight, gender, and inactivity, were associated with a higher prevalence of metabolic syndrome. Mexican-American adolescents were more likely to be overweight and inactive compared to Caucasians. Acculturation did not have a direct association with metabolic syndrome, but higher levels of acculturation were associated with increased physical activity and increased

daily intake of calories, carbohydrates, saturated fat, and the number of times eating meals outside the home.

Mexican American males were the most likely to have metabolic syndrome. Acculturation seems to be playing a role in the risk profile of Mexican-American adolescents, which increases their daily dietary intake that may contribute to metabolic syndrome via overweight. Acculturation also increased the likelihood of physical activity, but this association may be insufficient to override the other risk factors. These results suggest that acculturation should be considered when designing and implementing interventions or policies aimed at Mexican-American adolescents to reduce overweight, increase physical activity, and promote healthy dietary options. This may help to reduce the treatment costs associated with overweight and type-2 diabetes.

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CHAPTER 1
INTRODUCTION

For several decades researchers have known that certain metabolic markers were associated with type-2 diabetes and cardiovascular disease, but not until the 1980s did researchers identify a cluster of metabolic markers that seemed to be associated with an increased risk of developing these two conditions (Ferrannini, Haffner, Mitchell, & Stern, 1991; Haffner et al., 1992; G. M. Reaven, 1988). Recent advances in our understanding of these metabolic markers and their role in the risk profiles of type-2 diabetes and cardiovascular disease allowed for the formal designation of 'metabolic syndrome' to be assigned. Metabolic syndrome has been ascertained to cause a metabolic state known as insulin resistance, which increases the risk of developing two such disparate conditions as type-2 diabetes and cardiovascular disease (NCEP, 2002). Recent studies have found that metabolic syndrome may pose a greater risk for developing type-2 diabetes compared to cardiovascular disease (Sattar et al., 2003; Wilson, D'Agostino, Parise, Sullivan, & Meigs, 2005).

Obesity is one of the major determinants for developing metabolic. Research has shown that obese adults are much more likely to have metabolic syndrome compared to adults of normal weight (Palaniappan et al., 2004; Wilson, Kannel, Silbershatz, & D'Agostino, 1999). Considering the increasing trend towards overweight and obesity in adults seen over the last two decades (CDC, 2006c), these findings place metabolic syndrome at the intersection of the type-2 diabetes, cardiovascular disease, and obesity epidemics. By studying metabolic syndrome we may gain insights as to how overweight and obesity contribute to the incidence of type-2 diabetes and cardiovascular disease.

While it is important to understand how metabolic syndrome may contribute to type-2 diabetes and cardiovascular disease in adults, metabolic syndrome may pose more a greater threat to the health of children and adolescents. The last two decades have seen an unprecedented increase in the number of children and adolescents that are overweight[1] or at risk for overweight. There has been a virtually concomitant increase in the incidence and prevalence of type-2 diabetes in children and adolescents (CDC, 2006c). According to the Centers for Disease Control and Prevention (CDC) the increase has been of such magnitude that type-2 diabetes is no longer referred to as 'adult-onset diabetes' and is now considered one of the most common chronic diseases in children and adolescents (CDC, 2005a).

Studies performed on adolescents confirm that overweight is also a major predictor of developing metabolic syndrome, as it is in adults (Cook, Weitzman, Auinger, Nguyen, & Dietz, 2003; Weiss et al., 2004). The increases in overweight and type-2 diabetes implicate metabolic syndrome as a key factor in influencing health outcomes in children and adolescents. Research has shown that overweight is a critical risk factor for the development of metabolic syndrome, but it has not been to cause metabolic syndrome independently without other factors (e.g., behavioral or genetic) working in tandem (Grundy, 2004). Children and adolescents have been shown to possess behavioral factors that may contribute to the development of metabolic syndrome earlier in life. Two such factors are physical activity and diet.

[1] The term "obesity" is not used in pediatric populations because of the concern that children and adolescents will interpret it negatively. Instead the terms overweight and at risk for overweight are used (Klish, 2006).

There is a significant amount of research that links physical activity and diet to overweight in adolescents, one of the strongest predictors of metabolic syndrome (CDC, 2006d). Researchers have found that the rate at which physical activity is performed drops significantly beginning in childhood and continues to drop through adolescence (Aaron, Storti, Robertson, Kriska, & LaPorte, 2002; CDC, 2005b). Dietary patterns are also poor during adolescence. Studies show that some adolescents' erratic schedules and self perceptions can lead to skipped meals, which often contributes to weight gain because of heavy snacking on nutrient-poor foods (e.g., fast food), or overeating at meals they do eat (Cusatis & Shannon, 1996; Demory-Luce & Motil, 2006; LeLeiko & Rollinson, 1995). Both of these behavioral patterns may be increasing the likelihood of adolescent overweight and, consequently, the risk of developing metabolic syndrome.

Though the chance of developing metabolic syndrome may be increasing among all adolescents, Mexican-American adolescents may have a greater risk for developing of metabolic syndrome compared to adolescents from other racial/ethnic groups. This population's high prevalence of childhood overweight, low rates of physical activity, and poor dietary habits may be contributing factors. The increase in childhood overweight seen among adolescents has been particularly pronounced among Mexican-American adolescents. In 1998, 35% of Latino children had a BMI that classified them as overweight or at risk for overweight compared to only 20% of non-Latino white children (Ferguson et al., 1998). Between 1988-2000 the prevalence of overweight among Mexican-American adolescents increased by ten percentage points (Ogden, Flegal, Carroll, & Johnson, 2002). Mexican-American adolescents also perform less physical activity and consume more unhealthy foods compared to other adolescents. Mexican American girls were less likely (45.2%) than non-

Latino white girls (49.2%) to be physically active and among boys, Mexican Americans (54.5%) reported the lowest percentage of individuals participating in physical activity compared to non-Latino whites (72.4%) (Crespo et al., 2001). Mexican-American adolescents, and other Latino subgroups, in the U.S. have been shown to consume fewer foods associated with a traditional Latino diet and shift to foods that are either more popular or easily accessible in the United States. Traditional diets high in vegetables, meats, and whole grains are exchanged for increased intake of processed foods high in fat and sugar content (Unger et al., 2004).

One unifying concept to the observed rates of overweight, physical activity, and diet in adolescents is their body image and more specifically their perception of overweight. Studies among high school students have shown that the perception of overweight is intricately linked to their behavior. For example, the perception of overweight was a more powerful predictor of adolescents' physical activity and dietary patterns compared to medical definitions of overweight (Brener, Eaton, Lowry, & McManus, 2004; Strauss, 1999). Among Mexican-American adolescents, their perceptions of self and the world around them can be influenced by the phenomenon of acculturation. Acculturation is a process whereby the attitudes, beliefs, values, and behaviors of another culture are adopted (Abraido-Lanza, Armbrister, Florez, & Aguirre, 2006; Clark & Hofsess, 1998). If acculturation is able to influence the beliefs and behaviors of Mexican-American adolescents, it may play a role in determining their risk for metabolic syndrome.

Researchers have shown that first generation Latino adolescents are less likely to be overweight compared to second and third generation Latino adolescents (Gordon-Larsen, Harris, Ward, & Popkin, 2003; Popkin & Udry, 1998). These findings suggest that acculturation may be a relevant factor in the development of childhood overweight. Higher levels of acculturation have also been associated with a decreased rate of physical activity, dietary intake of fat, sodium, and consumption of fast food in children and adolescents (Mazur, Marquis, & Jensen, 2003; Unger et al., 2004). These data illustrate a trend towards less physical activity and a more unhealthy diet as acculturation increases. Thus, the level of acculturation possessed by Mexican-American adolescents may influence behavioral factors that in conjunction with overweight could be associated with the risk of developing metabolic syndrome.

The long term health effects associated with metabolic syndrome are staggering. Metabolic syndrome has been shown to be a risk factor for type-2 diabetes and cardiovascular disease, which are leading causes of morbidity and mortality. According to the Centers for Disease Control and Prevention, Latinos have the highest mortality due to diabetes. In the states bordering Mexico, where many Mexican Americans reside, the overall morbidity rate is 10 percentage points higher among Latinos than among non-Latino whites (CDC, 2006e). Even compared to other Latino subgroups, Mexican Americans were found to have the highest mortality rate due to type-2 diabetes (PAHO, 2005). Compared to other racial/ethnic groups, Latinos had the highest age-adjusted death rate attributed to cardiovascular disease and Mexican American children and adults have some of the highest rates of cardiovascular risk factors (P. Reaven, Nader, Berry, & Hoy, 1998; Thom et al., 2006).

The situation may already be worsening for Mexican-American adolescents relative to other racial or ethnic groups. There have already been cases of type-2 diabetes in Mexican American children as young as 10 years old (Trevino et al., 1999). Mexican-American adolescents and adults have been shown to have lower cardiorespiratory fitness compared to Caucasians, which places them at an increased risk for cardiovascular disease (Carnethon, Gulati, & Greenland, 2005). These figures, taken into consideration with the disproportionate number of overweight Mexican-American adolescents, can potentially have devastating health consequences. Thus, there is a strong motivation to understand the risk factors associated with type-2 diabetes and cardiovascular disease, such as metabolic syndrome, in this population. In Mexican-American adolescents factors such as acculturation, physical activity, diet and overweight, seem to be key determinants for metabolic syndrome. A clear understanding of the relationships between these factors and metabolic syndrome may suggest useful ways to reduce the morbidity or mortality caused by type-2 diabetes and cardiovascular disease.

Examining the risk factors of metabolic syndrome in Mexican-American adolescents has important implications for the U.S. health care system as a whole. According to the U.S. Census Bureau, approximately 14% of the U.S. population is of Latino ethnicity and Mexican Americans represent about 65% of the U.S. Latino population. Thirty-seven percent of Latinos are under the age of 20, 63% of Latino families have children under the age of 18, and 22% of families have children under the age of five (U.S. Census Bureau, 2006). Current estimates show that Latinos are the fastest growing group in the U.S. and by 2050 Latinos are projected to account for almost a quarter of the total U.S. population. Due to the rapid growth, young demographic, and the disproportionate prevalence of childhood overweight in Latinos, addressing the problem of metabolic syndrome in Latino adolescents, especially among Mexican-American adolescents, is of utmost importance. Studying metabolic syndrome and its potential behavioral determinants in Mexican-American adolescents has the potential to yield information to help reduce the burden that type-2 diabetes and cardiovascular disease may have on the health care system now and into the future.

1.1 Specific Aims

This study will examine the association of acculturation, physical activity, diet, and overweight on metabolic syndrome in Mexican-American adolescents. Specifically, the study has the following four specific aims.

Aim 1:

Determine if the prevalence of metabolic syndrome, rates of physical activity, dietary measures, and childhood overweight differ among Mexican Americans and non-Latino adolescents.

Aim 2:

Examine if physical activity and dietary measures are associated with metabolic syndrome in adolescents.

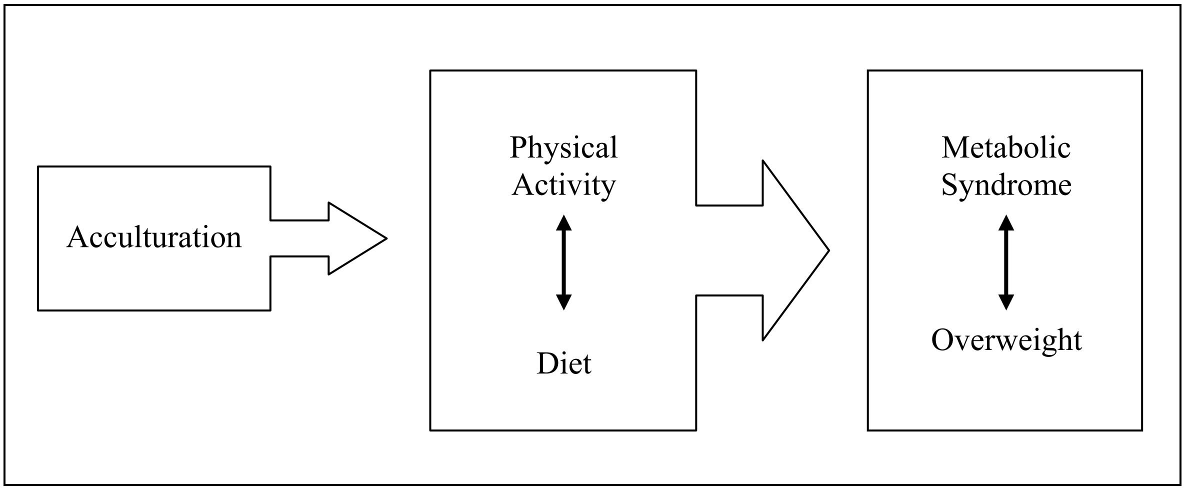
Aim 3:

Examine the association of acculturation on metabolic syndrome, physical activity, diet, and childhood overweight in Mexican-American adolescents.

1.2 Conceptual Framework

The conceptual model depicted below illustrates the predicted relationships between acculturation, physical activity, diet, overweight, and metabolic syndrome in U.S. adolescents that will guide the hypotheses associated with the specific aims listed above.

Figure 1.1 Conceptual Framework



The box on the right hand side of Figure 1.1 shows the established association of overweight as a risk factor for metabolic syndrome. Some studies suggest that having metabolic syndrome may increase the likelihood of overweight, but this is thought to be a weak association and there is much stronger evidence implicating overweight as a risk factor for metabolic syndrome (Cook, Weitzman, Auinger, Nguyen, & Dietz, 2003; Cruz, Bergman, & Goran, 2002; Weiss et al., 2004). A study of metabolic syndrome in U.S. adolescents, using national level data from 1988-1994, found a prevalence of 4.2% (Cook, Weitzman, Auinger, Nguyen, & Dietz, 2003). The same study found a significant difference in the prevalence of metabolic syndrome between adolescents of different racial/ethnic groups and between overweight and normal weight individuals with Mexican Americans having the highest percentage for both categories. Recent findings (1994-2006) regarding the continued disproportionate share of overweight in Mexican-American adolescents informs the first and second hypotheses associated with the first specific aim.

- H1: The prevalence of metabolic syndrome will be higher among Mexican-American adolescents compared to non-Latino adolescents.

- H2: Childhood overweight will be more prevalent among Mexican Americans compared to non-Latino adolescents.

The center box shows the behavioral components of physical activity and diet. Adolescents, especially Mexican Americans adolescents, have been shown to have lower rates of physical activity and more unhealthy diets compared to whites. There has been no indication that these trends have slowed in recent years. Therefore hypotheses 3-4 of the first specific aim are as follows:

- H3: Physical activity will be lower among Mexican-American adolescents compared to non-Latino adolescents.
- H4: Mexican-American adolescents will have less healthy dietary intake compared to non-Latino adolescents.

There is also some evidence implicating physical activity and diet as risk factors for metabolic syndrome and overweight in adults (Park et al., 2003). There are no such studies in adolescents, but associations found in the adult literature may be applicable to adolescents. For example, low rates of physical activity and an unhealthy diet have been associated with obesity in adults (CDC, 2006d). In adolescents, studies have also shown that overweight is associated with a low rate of physical activity and unhealthy dietary patterns (CDC, 2006d). There is also research in adults and adolescents that links overweight with an increased risk for metabolic syndrome. It seems likely that physical activity and diet would be similarly associated with metabolic syndrome in adolescents. Therefore, the association depicted by the arrow coming from the physical activity/diet box to the metabolic syndrome/overweight box has been surmised based mostly on findings from the adult literature and will be examined in an adolescent population in this study. Hypotheses 5-6 under the second specific aim will guide this portion of the analysis.

- H5: Lower rates of physical activity will be associated with a higher prevalence of metabolic syndrome.
- H6: Unhealthy dietary intakes will be associated with a higher prevalence of metabolic syndrome.

A few studies have shown that Latino, in particular Mexican American, children and adolescents had an increased risk of becoming insulin resistant (Batey et al., 1997; Cruz et al., 2004; Goran, Bergman, Cruz, & Watanabe, 2002). As described above, insulin resistance is a metabolic state facilitated by metabolic syndrome and known to contribute to the development of type-2 diabetes and cardiovascular disease. Given findings that Mexican-American adolescents have an increased risk for insulin resistance compared to other adolescents it suggests some factor is either unique or exerts more influence on Mexican-American adolescents to make them more susceptible to developing insulin resistance through metabolic syndrome.

Acculturation seems to be a likely candidate causing this increased susceptibility to insulin resistance due to its prominence in Mexican Americans, and other Latino sub-groups, compared to non-Latino adolescents. Acculturation has also been associated with factors, such as physical activity, diet, and overweight that can contribute to the development of metabolic syndrome (Gordon-Larsen, Harris, Ward, & Popkin, 2003; Popkin & Udry, 1998; Unger et al., 2004). This association is depicted by the arrow extending from the acculturation box to the second box containing physical activity/diet. The association between acculturation, physical activity, diet, and overweight in Latinos gives reason to suspect that acculturation may be indirectly driving the risk for metabolic syndrome in Mexican-American adolescents due to its ability to influence the rate of physical activity, dietary patterns, and weight gain. In this study, acculturation is not predicted to have a direct effect on metabolic syndrome; rather it is postulated to exert its influence on metabolic syndrome through physical activity, diet, and overweight leading to the following three hypotheses to address the third specific aim.

- H7: Mexican-American adolescents with higher levels of acculturation will be more likely to be overweight.
- H8: Mexican-American adolescents with higher levels of acculturation will demonstrate a decreased level of physical activity.
- H9: Diet will become less healthy as the level of acculturation increases in Mexican-American adolescents.

1.3 Significance and Implications

The American Diabetes Association estimated that in 2002 the total direct and indirect costs of diabetes and its complications was $132 billion or roughly one out of every 10 health care dollars spent that year (Hogan, Dall, & Nikolov, 2003). According to the American Heart Association and the National Heart, Lung, and Blood Institute the direct and indirect costs of cardiovascular disease and stroke in 2006 are estimated to be $403 billion (American Heart Association, 2006). The presence of metabolic syndrome in adolescence could cause type-2 diabetes and cardiovascular disease to occur at a younger age, which would translate into greater expenditures to care for these patients over a longer period of time.

Already there are signs that the health of adolescents is being adversely affected by type-2 diabetes and cardiovascular disease. It has been estimated that 33% of males and 39% of females born in the year 2000 will develop diabetes in adulthood and lose 12 or 19 life-years, respectively (Narayan, Boyle, Thompson, Sorensen, & Williamson, 2003). Atherosclerosis, which is responsible for almost all cases of coronary heart disease, has been found to begin in adolescence. Detection of this and other cardiovascular risk factors in adolescence can be predictors of development of cardiovascular disease later in life (Li et al., 2003; Raitakari et al., 2003; Wilson & Culleton, 2006). This emphasizes the importance of understanding metabolic syndrome in adolescents, which is a major risk factor for these two conditions, in an effort to prevent earlier onset and reduce the burden of disease.

The proposed analysis has the potential to make several significant contributions. First, using the most recent national-level data it will examine the current prevalence of metabolic syndrome in adolescents. Second, this analysis will describe the association of acculturation on physical activity, diet, and metabolic syndrome in Mexican-American adolescents which can fill a gap in the current literature. Third, examine the potential associations of physical activity or diet on metabolic syndrome in Mexican-American adolescents conditional on their level of acculturation. This may help explain why overweight and type-2 diabetes have become such prominent health concerns in this population and potentially point towards an increase in the rates of cardiovascular disease in Mexican Americans in the future.

Experts agree that the most effective way to combat metabolic syndrome and its ability to elevate the risk for type-2 diabetes and cardiovascular disease is to target its root causes (NCEP, 2002). Thus, this analysis has the potential to provide information that can be used to inform health intervention strategies and health policy initiatives aimed at reducing the number of Mexican-American adolescents with metabolic syndrome and in doing so reducing the burden of type-2 diabetes and cardiovascular disease in Mexican Americans, and on the U.S. health care system.

CHAPTER 2
LITERATURE REVIEW

2.1 Metabolic Syndrome

2.1.1 Metabolic Syndrome in Adults

Metabolic syndrome (also known as insulin resistance syndrome, syndrome X, etc.) is the clinical designation for a host of co-occurring physiologic traits that have been associated with an increased risk for type-2 diabetes and cardiovascular disease (Eisenmann, 2003; Meigs, 2006; Moller & Flier, 1991). There is some contention regarding how to properly define metabolic syndrome as evidenced by the different definitions proposed by the World Health Organization (1998), National Cholesterol Education Program Adult Treatment Panel III (ATP III, 2001), and the International Diabetes Federation (IDF) (2004) (Alberti, Zimmet, & Shaw, 2005; Alberti & Zimmet, 1998; NCEP, 2002). The ATP III definition was updated in 2005 in order to take advantage of more recent information (Grundy et al., 2005). These three definitions are similar, but they do lead to slightly different estimates of metabolic syndrome. For example, a study using NHANES 1999-2002 data found a 4.5 percentage point difference in the prevalence of metabolic syndrome using the ATP III definition versus the IDF definition, where the IDF definition resulted in a higher prevalence estimate (Ford, 2005). However, these two definitions agreed on the presence of metabolic syndrome in approximately 93% of subjects. The use of various definitions for metabolic syndrome makes it difficult to compare findings across studies.

In the United States the ATP III definition has been the most common definition used to assess the prevalence of metabolic syndrome. Using data from the Third National Health and Nutrition Examination Survey (NHANES III) the overall prevalence of metabolic syndrome in adults (20+ years) was 22% (Ford, Giles, & Dietz, 2002). The same study found an age related increase in the prevalence of metabolic syndrome (e.g., 20-29 [6.7%] and 60-69 [43.5%]), Mexican Americans had the highest age-adjusted rate (~32%), and men (7%) were more likely than women (6%) to have metabolic syndrome. More recent studies have demonstrated that the prevalence of metabolic syndrome is continuing to increase. A study using the Framingham Heart Study cohort found that men had an age-adjusted increase of 56% and women had an age-adjusted increase of 47% after an 8 year follow-up (Wilson, D'Agostino, Parise, Sullivan, & Meigs, 2005). Most recently, the San Antonio Heart Study used the ATP III definition to conclude that metabolic syndrome has increased between 1979-1982 and 1984-1988 (Lorenzo, Williams, Hunt, & Haffner, 2006).

In addition to age, race/ethnicity, and gender there are other risk factors for developing metabolic syndrome that should be considered in adults: obesity, lack of physical activity, a high carbohydrate diet, smoking, and low household income (Park et al., 2003). Studies have suggested that the growing prevalence of obesity in US adults is a major cause of the increase in metabolic syndrome to date and has the potential to drive further increases in the future. Using data from NHANES III the prevalence of metabolic syndrome was much higher in individuals who were overweight or obese (normal weight-5%, overweight-22%, and obese-60%) (Wilson, Kannel, Silbershatz, & D'Agostino, 1999). Other studies have attributed a 2.25 kg increase in weight, over 16 years, with a 21-45% increased risk of developing metabolic syndrome and increased waist circumference (abdominal obesity) alone has identified up to 46% of individuals developing metabolic syndrome within five years (Palaniappan et al., 2004; Wilson, Kannel, Silbershatz, & D'Agostino, 1999).

2.1.2 Metabolic Syndrome in adolescents

Metabolic syndrome has also been identified in adolescents. There have been several attempts to find ways to quantify metabolic syndrome in adolescents; however, a consensus definition of metabolic syndrome has not been established (Meigs, 2006; NCEP, 2002). Several U.S. and international studies have attempted to estimate the prevalence of metabolic syndrome in children and adolescents using a variety of definitions. These studies estimate that two to nine percent of children and adolescents are affected by metabolic syndrome (Chen, Srinivasan, Elkasabany, & Berenson, 1999; Csabi, Torok, Jeges, & Molnar, 2000; Dwyer et al., 2002; Maffeis, Pietrobelli, Grezzani, Provera, & Tato, 2001).

Regardless of definition, research demonstrates a relationship between overweight and metabolic syndrome among children and adolescents. Using data from NHANES III, the overall prevalence of metabolic syndrome was 4.2% among adolescents 12-19 years old. Furthermore, it was found that the prevalence of metabolic syndrome increased with higher BMI; normal weight adolescents (0.1%) were much lower than those at risk for overweight (~7%) or those who were overweight (29%) (Cook, Weitzman, Auinger, Nguyen, & Dietz, 2003). Using slightly different criteria for metabolic syndrome, also found that the prevalence of metabolic syndrome increased with childhood overweight among children and adolescents 4-20 years old (Weiss et al., 2004). In severely overweight children and adolescents (BMI >97th percentile for age and gender, mean BMI: 41), the same study found a 50% prevalence of metabolic syndrome and markers predictive of adverse cardiovascular outcomes.

2.1.3 Metabolic Syndrome as a Risk Factor

Metabolic syndrome is an important clinical entity because of its role as a risk factor for the development of type-2 diabetes and cardiovascular disease (NCEP, 2002). Data gathered from non-diabetic Pima Indians found that those with metabolic syndrome had an increased relative risk of approximately two-three fold for developing type-2 diabetes when metabolic syndrome was defined by the ATP III or WHO definitions, respectively (Hanson, Imperatore, Bennett, & Knowler, 2002). Other studies have found a 7-34 fold increase and a population attributable risk of 60% in men and 45% in women for developing type-2 diabetes in predominantly Caucasian populations (Klein, Klein, & Lee, 2002; Sattar et al., 2003; Wilson, D'Agostino, Parise, Sullivan, & Meigs, 2005). Among adolescents with metabolic syndrome at baseline, 23.5% were diagnosed with type-2 diabetes during a two year follow-up (Weiss et al., 2004).

There is also a great deal of evidence that links metabolic syndrome with an increased probability of developing cardiovascular disease (Girman et al., 2004; Kip et al., 2004; Lakka et al., 2002; Lorenzo, Williams, Hunt, & Haffner, 2006; Malik et al., 2004; Sattar et al., 2003; Wilson, D'Agostino, Parise, Sullivan, & Meigs, 2005). Some of these studies found that metabolic syndrome was a stronger risk factor for type-2 diabetes than for cardiovascular disease. One study found a hazard ratio of 3.5 for developing type-2 diabetes versus a hazard ratio of 1.8 for developing cardiovascular disease and another study found that the association of metabolic syndrome with type-2 diabetes was ~33% stronger compared to the association of metabolic syndrome and cardiovascular disease (Sattar et al., 2003; Wilson, D'Agostino, Parise, Sullivan, & Meigs, 2005).

Metabolic syndrome is able to increase the risk of two such disparate conditions by facilitating a metabolic state known as insulin resistance. Insulin is produced by the pancreas and is responsible for regulating the level of glucose in the blood. When glucose levels are too high insulin is secreted into the bloodstream, it binds to insulin receptors primarily on fat and skeletal tissues, which triggers those tissues to take up glucose from the blood (Mantzoros & Serdy, 2006). Insulin resistance occurs when insulin removes glucose from the blood at a suboptimal rate (Moller & Flier, 1991). This paves the way for hyperglycemia (high blood sugar). Insulin resistance and hyperglycemia are hallmarks of type-2 diabetes (McCulloch & Robertson, 2006). Insulin resistance has also been associated with an abnormal lipid profile, hypertension, and vascular inflammation, which are precursors for cardiovascular disease (Koh, Han, & Quon, 2005; Lindsay & Howard, 2004).

These findings are consistent with previous studies attributing obesity, especially abdominal adiposity, and a sedentary lifestyle with an increased risk of developing metabolic syndrome (Eisenmann, 2003; Flegal, Carroll, Ogden, & Johnson, 2002; Steinberger & Daniels, 2003). While overweight is an important risk factor for metabolic syndrome it is not believed to be able to cause full blown metabolic syndrome without other factors working in tandem (e.g., genetic, behavioral, and environmental factors) (Grundy, 2004). Metabolic syndrome is a key risk factor for understanding the current type-2 diabetes epidemic in adolescents and their future risk of developing cardiovascular disease as adults.

2.1.4 Genetic Predisposition for Metabolic Syndrome

While the aim of this study is to better understand metabolic syndrome in Mexican-American adolescents through the examination of behavioral and socio-cultural factors it is important to understand that metabolic syndrome does not result exclusively from modifiable behaviors. In certain groups of individuals, heritable genetic factors (i.e., a family history) have been shown to contribute towards the susceptibility of a variety of disease conditions (CDC, 2006b). Recent work has begun to provide some insight into the potential role of genetics in the development of metabolic syndrome. Thus, while this study will not examine genetic factors that are potentially linked to metabolic syndrome, a summary of recent work in this field is presented to provide a more complete picture of the factors that contribute to the development of metabolic syndrome.

Research has begun to identify genes[2] associated with metabolic syndrome. In Europeans and American Indians there is evidence of a region on human chromosome[3] 1q that is related to the predisposition of diabetes or hyperglycemia (Elbein, Hoffman, Teng, Leppert, & Hasstedt, 1999; Hanson et al., 1998; Hsueh et al., 2003; J. B. Meigs, Panhuysen, Myers, Wilson, & Cupples, 2002; Vionnet et al., 2000; Wiltshire et al., 2001). Another study found that human chromosome 1q was also linked to diabetes-related susceptibility as well as possibly influencing other metabolic disorders among a predominantly Mexican American cohort (Langefeld et al., 2004). This discovery is intuitive considering that Mexican Americans have European and American Indian ancestors.

Positive familial correlations among Mexican Americans have been linked to an increase in both birth weight and to metabolic syndrome traits in adulthood (Stern, Bartley, Duggirala, & Bradshaw, 2000). Variation in the liproprotein lipase gene—which is linked to insulin resistance, hypertension, obesity and other factors—has also been found to be associated with insulin sensitivity in Mexican Americans with a family history of

[2] A gene is a section of DNA that encodes information for a single product (e.g., an enzyme).
[3] Chromosomes are composed of a molecule of DNA with specific genes encoding hereditary information.

cardiovascular disease (Goodarzi et al., 2004). Another locus[4] close to the lipoprotein lipase gene on chromosome 8p has been associated with a strong linkage to insulin resistance in Mexican Americans in the San Antonio Family Heart Study (Cai et al., 2004). The metabolic clearance rate of insulin has been found to be a highly heritable trait and quantitative differences in the metabolic clearance rate of insulin in Mexican Americans have been closely linked to specific haplotypes[5] in the AMP deaminase 1 gene (Goodarzi, Taylor, Guo, Quinones, Cui, Li, Hang et al., 2005). Even some genes that were previously reported to be correlated with hypertension (AGT, NOS3, NPPA, ADRB2, ADD1, and SCNN1A) have also been linked to insulin resistance in Mexican Americans (Guo et al., 2005). These studies suggest that Mexican Americans may be more susceptible to developing metabolic syndrome if they possess some of the genetic traits above that have been linked with insulin resistance.

Adipose (fat) tissue secretes various proteins (collectively referred to as adipokines), which have been correlated to insulin sensitivity and possibly energy balance via their role in the metabolism of lipids and glucose (Civitarese et al., 2004). One such protein is called adiponectin. A study performed on Pima Indians found that high plasma concentrations of adiponectin reduced the probability of developing type-2 diabetes (Lindsay et al., 2002). This finding was expanded in a cohort of healthy Mexican Americans, with a family history of type-2 diabetes; the expression of two adiponectin receptors (*AdipoR1* and *AdipoR2*) as well as plasma concentrations of adiponectin were lower compared to Mexican Americans from families with no family history of type-2 diabetes (Civitarese et al., 2004). The authors conclude that these results further substantiate the belief that adiponectin can affect insulin sensitivity and the development of type-2 diabetes. These adiponectin findings are interesting

[4] A genetic locus is the position of a gene on a chromosome.
[5] A haplotype is a set of closely linked genetic elements that are usually on a single chromosome and inherited as a group.

because they allude to a potentially built-in mechanism to prevent insulin resistance even when high blood glucose levels exist and provide another potential genetic link to the development of metabolic syndrome.

Another adipokine found to influence lipid metabolism, obesity, and glucose regulation is acylation-stimulating protein (ASP). Its expression has been linked to loci on chromosomes 15 and 17, which is interesting because the areas surrounding the ASP loci have previously been identified as influencing obesity and lipid metabolism in Mexican Americans (Martin et al., 2004). The findings on the ASP loci not only provide a genetic link to three factors known to be associated with metabolic syndrome, but the findings also illustrate how the genetic regulation of many metabolic factors may have very close genetic ties.

Research has demonstrated that cardiovascular disease and type-2 diabetes both have a strong genetic basis and often co-occur (Mitchell & Imumorin, 2002; Motulsky & Brunzell, 2002). A possible explanation is that these two conditions may share genetic factors that can lead to increased susceptibility. Several haplotypes from the gene calpain-10, located on chromosome 2q37, were associated with sub-clinical atherosclerosis, insulin sensitivity, and secretion of insulin in Mexican American families with a history of cardiovascular disease (Goodarzi, Taylor, Guo, Quinones, Cui, Li, Saad et al., 2005). Loci on chromosomes 2, 6, and 13 have also been implicated as possible locations for a gene or genes that influence intima-meida thickness—a sub-clinical measure of atherosclerosis (Wang et al., 2005). These studies make a case for shared or linked genetic factors that may help explain why type-2 diabetes and cardiovascular disease commonly co-occur. The specific genetic traits discussed also provides evidence to help explain how metabolic syndrome is able to increase the risk of both type-2 diabetes and cardiovascular disease.

These studies illustrate that a genetic component is clearly part of the underlying mechanisms leading to the development of metabolic syndrome, type-2 diabetes, and cardiovascular disease. It is also evident that these conditions are tightly interwoven and part of complex multi-gene pathways that researchers are only now beginning to comprehend. It is important to view the influence of genetics as one component in a multi-component risk profile for metabolic syndrome, which also includes a behavioral as well as an environmental component. Researchers generally agree that populations with a genetic predisposition for insulin resistance, such as Mexican Americans, and other acquired risk factors (e.g., diet, sedentary lifestyle, and overweight) have a much higher probability of developing metabolic syndrome compared to those who are not genetically predisposed to insulin resistance (NCEP, 2002). These findings may seem to indicate that genetics may be partially responsible for the disproportionate rates of metabolic syndrome, type-2 diabetes, and overweight in Mexican Americans. If Mexican Americans have a genetic predisposition to metabolic syndrome it is more important to modulate behavioral factors that can reduce their risk for metabolic syndrome and overweight.

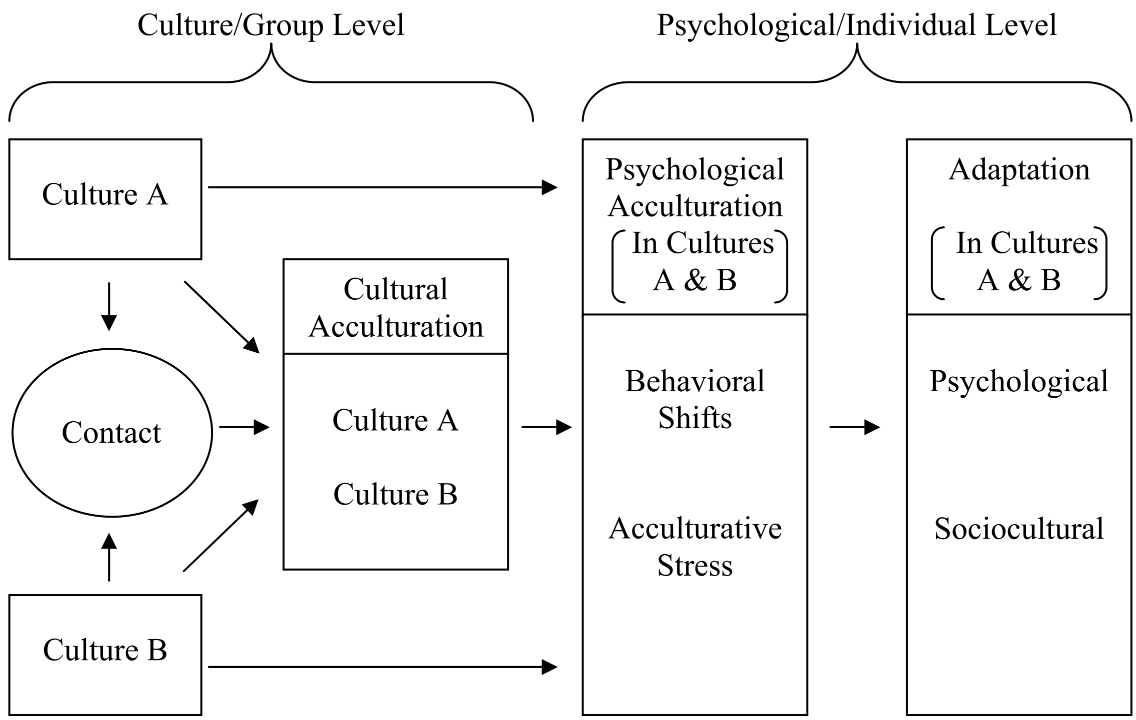
2.2 Acculturation

Acculturation can create difficulties or lifestyle changes that can positively or negatively affect the health of immigrant or U.S. born Latinos (Abraido-Lanza, Armbrister, Florez, & Aguirre, 2006). Researchers have discovered that there are challenges to including acculturation in health services research. First, there are several competing theories and conceptual frameworks applied to the process of acculturation. Second, there is no consensus as to how to appropriately measure acculturation. There are two unanswered questions that underpin the majority of the acculturation debate. Is acculturation a mutual process where the dominant and non-dominant groups are both affected? Is acculturation a unidimensional or a multidimensional process? The current thinking for both these questions is discussed below.

2.2.1 Conceptual Approaches to Acculturation

Much of the work done in conceptualizing acculturation has been done in the field of psychology. According to research done in cross-cultural psychology, in order to understand an individual's acculturation process one must first understand the two cultures that have come in contact to initiate the process of acculturation (Berry, 2003). Understanding both cultures is important because not only is the individual being affected by the dominant culture, but also by the changing culture to which the individual belongs. It is also important to remember that every individual will acculturate differently because each person enters or participates in the dominant culture differently and individuals will change (i.e., acculturate) to differing degrees (Berry, 2003; Graves, 1967). This can be illustrated in a general acculturation framework that has been used to conceptualize and create measures for acculturation.

Figure 2.1 General Acculturation Framework



[Modified from Berry, 2003]

Figure 2.1 clearly shows that there is a cultural (group level) acculturation and a psychological (individual level) acculturation that takes place. At the group level both cultures have the potential to change as a result of their continuous contact. At the individual level acculturation can manifest as behavioral changes such as language preference, diet, or cultural identity. It can also manifest as acculturative stress, which results in mental health changes such as anxiety or depression (Berry, 2003). Either behavioral changes or acculturative stress can potentially affect the health of individuals or groups of people. Adaptation is also a part of acculturation. Adaptation can be psychological (e.g., self-esteem) or socio-cultural, which can manifest in the way an individual links themselves to others in the dominant culture (Berry, 2003; Searle & Ward, 1990). This framework allows for change to occur to both the non-dominant and the dominant cultures as well as at an individual level.

Given the general framework of acculturation there are two competing views that describe how the process of acculturation occurs: a unidimensional or a multidimensional process. The unidimensional approach assumes that people acculturate to the dominant culture while their ties to the non-dominant culture simultaneously weaken (Zane & Mak, 2003). The implication is that only the non-dominant culture changes while the dominant culture does not. The multidimensional view allows for acculturation to the dominant culture and retention of the non-dominant culture to occur independently (Zane & Mak, 2003). This allows for aspects of the non-dominant and the dominant culture to change. The multidimensional viewpoint of acculturation was originally developed in 1936 when anthropologists originally suggested that the unidimensional process of assimilation—abandoning the original cultural patterns and completely adopting the cultural patterns of the dominant society—was not the only form of acculturation (Berry, 2003).

Figure 2.2 Multidimensional Acculturation Strategies

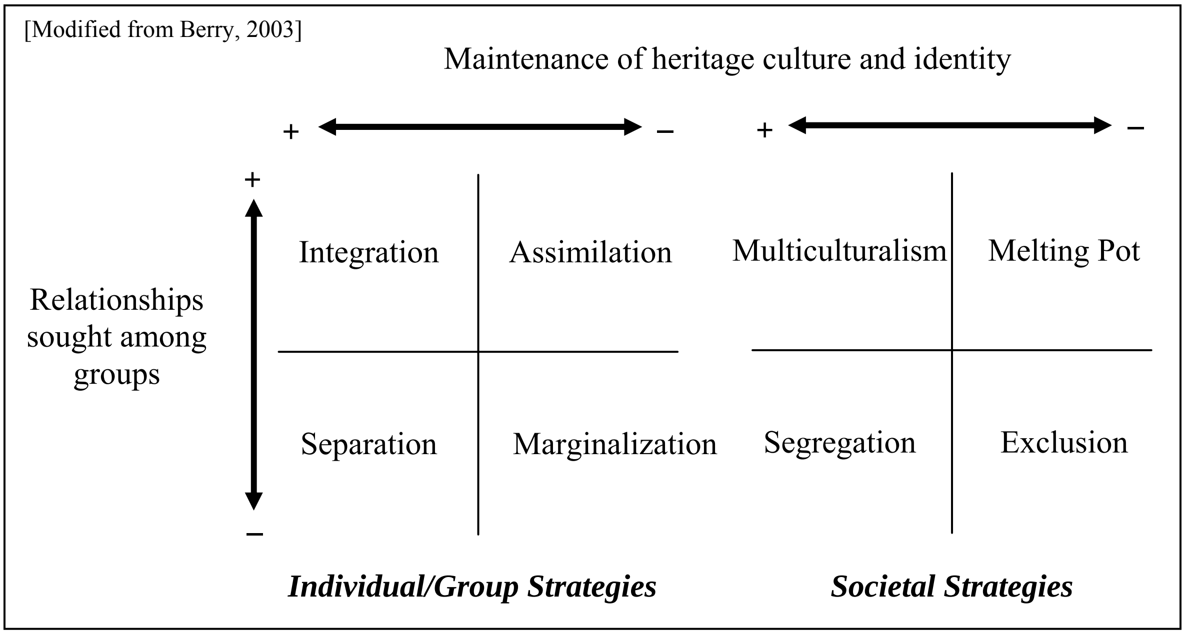


Figure 2.2 illustrates multidimensional acculturation strategies for individuals/groups and for the larger society. These acculturation strategies depend on the degree that individuals/groups or societies want to retain their cultural identity (x axis) and their desire to interact with the dominant society or with other cultural groups (y axis) (Berry, 2003). As stated before, both of these can occur independently so depending on the extent of these two criteria one can discern an acculturation strategy. These strategies also differ if they are viewed in the context of the non-dominant culture/group (left grid) or the dominant culture (right grid) (Berry, 2003).

For individuals/groups the two most extreme strategies are assimilation and marginalization. For Latinos, assimilation is when American culture completely replaces the native culture and when these individuals are also accepted as Americans by the dominant society (Buriel & De Ment, 1997; Fernandez-Kelly, 1998). Some think of assimilation as being synonymous with Americanization where immigrants would reject their past and "act American" (Acuna, 2003). The physical attributes of Mexican Americans and other Latino subgroups have triggered prejudicial and stereotypical attitudes about their "foreign" backgrounds and these attitudes have been obstacles to accessing societal resources and to full assimilation into American society (Buriel & De Ment, 1997; Harrison, Wilson, Pine, Chan, & Buriel, 1990). Therefore, other acculturation strategies are more likely to occur.

Marginalization describes a process where there is neither desire to retain the non-dominant cultural identity nor a desire to adopt the dominant culture. In many instances marginalization occurs when the non-dominant culture is rejected in conjunction with a failed attempt to assimilate and a failed attempt at participating in the dominant culture (Berry, 2003). Berry (2003) suggests that marginalization is a product of discrimination on the part of the dominant culture.

Integration and separation are more moderate acculturation strategies. When there is a desire to maintain the non-dominant cultural identity and also interact with the dominant culture it leads to integration. Individuals or groups that have integrated into a society are thought of as bicultural. Bicultural individuals have the advantage of being able to function in more than one culture allowing them to move between the dominant culture and their native culture; allowing access to American culture without sacrificing their native heritage (Buriel & De Ment, 1997; Harrison, Wilson, Pine, Chan, & Buriel, 1990). Separation is similar because the preservation of the non-dominant cultural identity is strong, but there is a lack of desire to interact with the dominant culture. Prior to entering the U.S. immigrants identified themselves by their nationality, but upon arriving in the U.S. this identity is frequently blurred by being labeled simply "Hispanic" (Fernandez-Kelly, 1998). This can affect access to tangible and intangible resources (e.g., information) because group membership can affect the resources available to them, but also provide a feeling of security (Fernandez-Kelly, 1998). The strategy of separation may help foster a feeling of security by interacting with members of the same group, while excluding or minimizing interaction with the dominant cultural group.

It is important to remember that the acculturation strategies in the left grid depend on the assumption that the members of the non-dominant group have the freedom to choose their acculturation strategy, but the dominant culture can force or constrain the acculturation choices available to the non-dominant group (Berry, 2003). The ability of the dominant culture to influence the acculturation strategies of non-dominant groups is consistent with the postulated ability of both the non-dominant and the dominant culture to change during the acculturation process (Figure 2.1). The grid on the right illustrates scenarios when the response of the dominant culture to the acculturating non-dominant group is considered. For example, when the dominant culture expects assimilation and the non-dominant group wants to assimilate the result is a melting pot society. If the dominant group forces separation (lack of interaction with the dominant group) on the non-dominant group then the society is segregated. Many people talk about a multicultural society, but it can only exist when the non-dominant group wants to integrate and the dominant group views diversity as a positive societal trait. In this situation both the dominant and the non-dominant groups are required to change or acculturate to each other.

2.2.2 Measuring Acculturation

The conceptualization of acculturation is a point of contention among researchers, which has created an operational dilemma. How a researcher conceptualizes acculturation will directly affect how acculturation is measured. Given that there are different ways of conceptualizing acculturation it is no surprise that a variety of acculturation instruments have been created, some using a unidimensional approach and others a multidimensional approach. The dimensionality can affect the number or type of domains used in the design of acculturation scales. Domains used include language (use, proficiency, or preference), communication styles, social affiliation, daily living habits, perceived prejudice or discrimination, family socialization, cultural attributes (knowledge, beliefs, values, identification, pride, traditions, or acceptance), and length of residence in U.S. (years in U.S., generational status, or age at arrival) (Arcia, Skinner, Bailey, & Correa, 2001; Zane & Mak, 2003). Some have questioned the content validity of acculturation measures because of a lack of consensus regarding which domains are directly associated with acculturative change (Zane & Mak, 2003).

The most frequently assessed domain in acculturation instruments is language (Zane & Mak, 2003). Some have argued that language is the most robust indicator of acculturation (Burnam, Telles, Karno, & Hough, 1987; Cuellar, Harris, & Jasso, 1980; Marks et al., 1987; Padilla, 1980). However, the way in which language is assessed is not consistent across acculturation instruments. For example, the Children's Hispanic Background Scale assess language use, the Bicultural Involvement Questionnaire assesses language preference, and the Bidimensional Acculturation Scale uses language proficiency (Marin & Gamba, 1996; Martinez, Norman, & Delaney, 1984; Szapocznik, Kurtines, & Fernandez, 1980). The differences in measuring acculturation with language also vary by the context in which the questions are asked. Some instruments measure language in general, while others use specific social contexts (e.g., with family members, friends, or at work) (Zane & Mak, 2003).

In addition to language, social or cultural domains are commonly used measures of acculturation. Some scales only look at actual social affiliations while others also incorporate social preferences (Mendoza, 1989; M. Ramirez, 1983). Daily living habits such as diet or music preferences are also not uncommon (Landrine & Klonoff, 1994; Szapocznik, Kurtines, & Fernandez, 1980; Szapocznik, Scopetta, Kurtines, & de los Angeles Aranalde, 1978). There are further differences based on whether the scale measures only actual daily living habits or also includes preferences about daily living habits. There are also acculturation instruments that attempt to assess identification with a particular culture, non-dominant or dominant. These instruments vary by assessing actual identification, cultural pride, or perceived acceptance by a certain cultural group (Cuellar, Arnold, & Maldonado, 1995; Mendoza, 1989).

Most acculturation instruments are designed for a heterogeneous group, such as Latinos or Asian-Americans; others are designed for a specific subgroup. Among Latino subgroups, there are acculturation instruments developed specifically for Mexican Americans and Cuban Americans. The most widely used instrument to assess acculturation in Mexican Americans is the Acculturation Rating Scale for Mexican Americans (ARSMA) (Cuellar, Harris, & Jasso, 1980). The ARSMA originally developed in 1980 was revised in 1995 and is known as ARSMA-Revised or ARSMA-II (Cuellar, Arnold, & Maldonado, 1995). The ARSMA-II is a two-part questionnaire designed to assess the multiple dimensions of acculturation (i.e., assimilation, integration, separation, and marginalization). The first part assesses involvement in the Mexican or Anglo culture assessing language proficiency and preference, cultural practices, social affiliation, and ethnic identification (30 items). Part two employs 18 items that measure the acceptance of attitudes and behaviors in Mexican and

Anglo cultures. Many other acculturation instruments have been modeled after or adapted items from the ARSMA (Zane & Mak, 2003).

An example is the five-point likert scale used in the ARSMA to assess the degree of language use/preference and cultural identity/preference (Cuellar, Harris, & Jasso, 1980). A response of one indicates Mexican culture/Spanish speaking, a three is bicultural/bilingual, and a five represents Anglo culture/English speaking. This scale has been used or modified in at least six other acculturation instruments designed for Latinos (Franco, 1983; Marin, Sabogal, Marin, Otero-Sabogal, & Perez-Stable, 1987; Mendoza, 1989; Norris, Ford, & Bova, 1996; A. G. Ramirez, Cousins, Santos, & Supik, 1986; M. Ramirez, 1983). This not only illustrates the influence the ARSMA design has had within the field of acculturation research, but it also serves as a reminder that language is the most widely used domain in the assessment of acculturation.

2.3 Physical Activity

Decreased physical activity, or a sedentary lifestyle, has been implicated as a risk factor for metabolic syndrome in adults (Park et al., 2003). A direct link between physical activity and metabolic syndrome in adolescents has not been reported in the literature. However, it has been suggested that increased physical activity is a behavioral change that could help combat metabolic syndrome, as well as other conditions, in adolescents (Eisenmann, 2003). This seems to be a practical recommendation because lifestyle behavioral patterns are created during childhood and adolescence (Aarts, Paulussen, & Schaalma, 1997). If physical activity were to increase during childhood and adolescence there is a possibility that those increased activity patterns may carry over into adulthood and help control metabolic syndrome later in life as well as in adolescence.

Current research shows that decreasing rates of physical activity beginning in childhood and continuing through adolescence may be contributing toward a set of conditions that could be making adolescents more vulnerable to metabolic syndrome. More than one-third of U.S. adolescents in 9^{th}-12^{th} grades do not perform vigorous physical activity on a regular basis and a 14 percentage point drop was seen in regular attendance of physical education classes between 1993-2003 (CDC, 2005b). Physical activity has also been found to decrease up to 37% during adolescence (Aaron, Storti, Robertson, Kriska, & LaPorte, 2002). In the same study, by the time middle school students enter high school 85% report a reduction in physical activity. Data from the US Youth Risk Behavior Survey showed that from 1993-2003 there was increased inactivity among boys in 9^{th} -12^{th} grade and a reported decrease in physical activity among those who were active (Adams, 2006).

This pattern of decreased physical activity seems to be more pronounced in Latino children and adolescents. As a consequence Latino youth, particularly of Mexican descent, may face an increased likelihood of developing metabolic syndrome. Results from NHANES III show that Latino children (8-16 yrs.) performed less vigorous activities compared to non-Latino children (Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998). Seventy three percent of Latino girls reported three or more events of vigorous activity compared to 77% of non-Latino girls (Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998). Mexican American girls were less likely (45.2%) than non-Latino white girls (49.2%) to be physically active five or more times/week (Crespo et al., 2001). Among boys, Mexican Americans (54.5%) reported the lowest percentage of individuals participating in physical activity five or more times/week compared to non-Latino Whites (72.4%) (Crespo et al., 2001).

The perception of overweight is also important to consider when attempting to understand physical activity among adolescents. Several studies among high school students have shown that the perception of overweight is intricately linked to their behavior. For example, the perception of overweight was a more powerful predictor of adolescents' physical activity and dietary patterns compared to medical definitions of overweight (Brener, Eaton, Lowry, & McManus, 2004; Strauss, 1999). Perceptions of overweight are also linked to attempted weight loss even if they are not actually overweight (Strauss, 1999). This is critical information when taken into consideration along side adolescents' views of their own weight status. A study of 9^{th}-12^{th} graders showed that 1.5% were underweight and 47% were at risk for overweight or actually overweight according to CDC growth charts, but 35% perceived themselves to be underweight and 22% perceived themselves as overweight (Brener, Eaton, Lowry, & McManus, 2004). Among Mexican-American adolescents their acculturation status may influence how they perceive their weight. This provides some support to the assumption that acculturation can influence Mexican American physical activity patterns.

Another reason why Latinos perform less physical activity is that they are twice as likely as non-Latinos to view their neighborhoods as unsafe, which could deter youth from engaging in vigorous physical activities (Andersen, Crespo, Bartlett, Cheskin, & Pratt, 1998). It should be noted that the implication of these findings is that socioeconomic status is associated with adolescent physical activity and obesity, but the literature has produced inconclusive evidence to support or refute this association (Crawford, Story, Wang, Ritchie,

& Sabry, 2001; Haas et al., 2003). A recent study found that role models, support for physical activity, and a low fat diet are more prominent among families with greater income (Frenn et al., 2005). However, the same study found that Latinos living in an area with a high concentration of traditional Latino culture and foods had a protective effect against the effects of lower income on role models and intake of dietary fat. Socioeconomic status may also affect the level of acculturation attained. It is interesting to note that the reported findings of physical activity in conjunction with the findings on acculturation point to a possible association between acculturation, physical activity, and metabolic syndrome.

2.4 Diet

Research has shown that good nutrition can help prevent or reduce overweight and other chronic conditions (Demory-Luce & Motil, 2006; DHHS, 2000). Diet has been implicated as a key player in the control of metabolic syndrome (Deen, 2004; Eisenmann, 2003). During adolescence good nutrition is also necessary to accommodate the body's normal changes associated with puberty (LeLeiko & Rollinson, 1995; Spear, 1996). Based on this researchers have recommended the establishment of healthy eating habits during childhood and maintained during adolescence (Copperman, Haas, Arden, & Jacobson, 1997; Demory-Luce & Motil, 2006; Kimm, Gergen, Malloy, Dresser, & Carroll, 1990; Lifshitz, Tarim, & Smith, 1993; NCEP, 1992). Recommendations for good nutrition are usually set for specific macronutrients, but good nutrition is usually promoted to the public based on food groups for ease of comprehension (e.g., the food pyramid).

It is clear that many adolescents do not maintain healthy eating habits. National surveys have determined that adolescents often do not adhere to recommended dietary intakes (Cavadini, Siega-Riz, & Popkin, 2000; Kimm, Gergen, Malloy, Dresser, & Carroll, 1990; Stang, Story, Harnack, & Neumark-Sztainer, 2000). The less than exemplary dietary habits may stem from adolescents need to be accepted by their peers, perception of self, greater independence, and time spent outside the home (Fung & Anyan, 1997; Hendricks, Duggan, & Walker, 2000; LeLeiko & Rollinson, 1995; Siega-Riz, Carson, & Popkin, 1998). These factors can contribute to skipped meals, snacking, and consumption of fast food (Demory-Luce & Motil, 2006). The implication that diet can help control metabolic syndrome leads to the assumption that an unhealthy diet may contribute towards developing metabolic syndrome.

Adolescents erratic schedules and desire to control their weight can contribute to skipping meals, most frequently breakfast or lunch (Cusatis & Shannon, 1996; LeLeiko & Rollinson, 1995; Miller & Maropis, 1998; Spear, 1996). According to the National Adolescent School Health Survey over half of the adolescents surveyed ate breakfast less than twice/week (Lifshitz, Tarim, & Smith, 1993). This is disconcerting given that breakfast usually accounts for 21-26% of an adolescents total daily energy intake and those that skip breakfast have been found to have lower total nutritional intakes because of an inability to compensate for these nutritional loses at other meals (Nicklas, 1995; Nicklas, Bao, Webber, & Berenson, 1993; Nicklas, O'Neil, & Berenson, 1998; Siega-Riz, Popkin, & Carson, 1998; Spear, 1996). It has also been noted that adolescents that skip meals for weight control usually results in an unhealthy diet and unintended weight gain, partly because of heavy snacking on nutrient-poor foods or overeating at other meals (Cusatis & Shannon, 1996; LeLeiko & Rollinson, 1995). This pattern that adolescents demonstrate in their dietary choices may increase the risk of metabolic syndrome by increasing the change of overweight, a major risk factor for metabolic syndrome.

Over half of adolescents report eating a minimum of five times/day, which results in almost one-third of an adolescent's total energy intake coming from snacks (Bull, 1992; Burghardt, Devaney, & Gordon, 1995; Cusatis & Shannon, 1996). Snacks that are high in calories and low in nutrients may reduce the intake of more nutritious foods by suppressing appetite around mealtimes (LeLeiko & Rollinson, 1995; Lifshitz, Tarim, & Smith, 1993; Spear, 1996). However, snacks should not always be thought of as negative. If properly timed during the day and healthy foods selected, snacks can help meet the increased nutritional and energy demands of adolescence (LeLeiko & Rollinson, 1995).

Fast food is popular among adolescents for snacking or meals because it is readily available and inexpensive (Fung & Anyan, 1997; LeLeiko & Rollinson, 1995; Lifshitz, Tarim, & Smith, 1993). Some studies have found that over 80% of those who frequent fast food restaurants are under the age of 18 (CDC, 1994; Ranade, 1993). Fast food is generally unhealthy because over 50% of calories are from fat and these foods are usually high in sodium, and cholesterol (Fung & Anyan, 1997; Lifshitz, Tarim, & Smith, 1993; Spear, 1996). The health effects of fast food are dependent on the frequency of consumption and on the food choices made (American Academy of Pediatrics, 2004a). This point is especially important because many fast food restaurants now offer more healthy food options, but the portion sizes are larger compared to other restaurants (Fung & Anyan, 1997; Nielsen & Popkin, 2003).

It has also been shown that meals or snacks eaten away from home are usually higher in calories and contain more fat compared to foods prepared at home (Guthrie, Lin, &

Frazao, 2002). The reduction of portion sizes, caloric intake, saturated fat, and sodium even in the absence of weight loss, have been speculated to still have the ability to reduce the probability of developing metabolic syndrome, in conjunction with an improved physical activity profile (Deen, 2004). Thus, a reduction in fast food or unhealthy snacks seems to be a good way to help adolescents reduce their risk for metabolic syndrome, especially if overweight.

Socioeconomic status should also be considered when looking at access to or availability of food sources. Low-income individuals often live in neighborhoods where supermarkets are less common (Morland, Wing, Diez Roux, & Poole, 2002; Reidpath, Burns, Garrard, Mahoney, & Townsend, 2002). These same neighborhoods are twice as likely to have fast-food restaurants compared to wealthy neighborhoods. It has also been suggested that Latino women may perceive supermarkets as too expensive to adequately feed their families and if they are less acculturated, they may feel uncomfortable shopping at supermarkets due to language barriers or unavailability of desired foods (Ayala, Mueller, Lopez-Madurga, Campbell, & Elder, 2005). This may imply that Latino adolescents may have a harder time accessing healthy foods due to their parents' cultural barriers or their socioeconomic status.

Acculturation may also affect the dietary habits of Latinos. The acculturation process in U.S. Latinos has been shown to be associated with the development of unhealthy dietary behaviors such as eating more fast-food, less fiber, fruits, and vegetables; especially in women who are younger and have lived in the U.S. longer (Ayala, Mueller, Lopez-Madurga, Campbell, & Elder, 2005; M. S. Kaplan, Huguet, Newsom, & McFarland, 2004; Neuhouser, Thompson, Coronado, & Solomon, 2004; Satia-Abouta, Patterson, Neuhouser, & Elder, 2002). There is also evidence suggesting that as acculturation increases Latino's fat consumption, primarily via adding fat at the table (e.g., butter or margarine) becoming proportionally equal to the level of non-Latino whites (Neuhouser, Thompson, Coronado, & Solomon, 2004; Winkleby, Albright, Howard-Pitney, Lin, & Fortmann, 1994).

A recent study examining the effects of acculturation on diet in Latinos (~93% Mexican American) four to 16 years old found that lower levels of acculturation were associated with reduced consumption of energy from fat, lower sodium and macronutrient intakes (Mazur, Marquis, & Jensen, 2003). A study of 6th and 7th grade children found that higher levels of acculturation was associated with increased consumption of fast food and a decreased rate of physical activity (Unger et al., 2004). The authors conclude that higher levels of acculturation in 6th and 7th grade Latinos make it more likely that they engage in behaviors that will increase their risk for overweight. These findings regarding acculturation and diet seem to implicate an increased risk for metabolic syndrome as acculturation increases due to an increasingly unhealthy diet.

2.5 Trends in Overweight

The prevalence of overweight[6] children has steadily grown over the last forty years and during that time African Americans and Latino children, especially Mexican Americans, have experienced the largest increases (CDC, 1997; Haas et al., 2003; Lacar, Soto, & Riley, 2000; Martorell, Mendoza, & Castillo, 1989; M. K. Park, Menard, & Schoolfield, 2001; Troiano, Flegal, Kuczmarski, Campbell, & Johnson, 1995; Winkleby, Robinson, Sundquist, & Kraemer, 1999). In 1998, 35% of Latino children had a Body Mass Index (BMI) above

[6] The term "obesity" is not used in pediatric populations because of the concern that children and adolescents will interpret it negatively. Instead the terms overweight and at risk for overweight are used (Klish, 2006).

the 85th percentile compared to only 20% of Caucasian children, which places them at risk for overweight or classifies them as overweight (Ferguson et al., 1998). From 1986-1998 the number of Latino children and adolescents who are overweight has doubled (Strauss & Pollack, 2001). Between 1988-1994 the Centers for Disease Control and Prevention (CDC) reported that Latino boys and girls were the most overweight and second most overweight, respectively, among all racial/ethnic groups of children in the U.S. (CDC, 1997). The prevalence of overweight Mexican-American adolescents increased by ten percentage points, a rate which was equaled only by African American adolescents during 1988-2000 (Ogden, Flegal, Carroll, & Johnson, 2002). Finally, in 2002 almost 30% of U.S. children and adolescents were characterized as overweight or at risk for overweight (Hedley et al., 2004).

Studies have attempted to elaborate the parental role in childhood obesity. The results have been inconclusive with some studies citing a predisposition to childhood obesity if the parents were obese and others unable to show an association (Francis, Lee, & Birch, 2003; Treuth, Butte, & Wong, 2000). Studies have also proposed the way in which parents feed their children is partly determined by their perception of their child's risk for obesity (Birch & Fisher, 2000; Costanzo & Woody, 1985). In fact, studies have shown that Latino parents differed in the pressure they exerted on their children to eat compared to non-Latinos (Birch et al., 2001). Consideration has also been given to the perception that Latino women see heavier children as healthier children (Contento, Basch, & Zybert, 2003). The amount of food consumption expected of Latino adolescents and the parental perception of their adolescent's weight may be tied to the parent's level of acculturation.

This is a disturbing trend because over 99% of childhood and adolescent overweight is caused by behavioral factors, such as a lack of physical activity or excessive caloric intake

(Klish, 2006; Ogden, Flegal, Carroll, & Johnson, 2002; Speiser et al., 2005). The potential health outcomes for overweight in adolescents include adverse lipid profiles, impaired glucose tolerance, type-2 diabetes, and hypertension (Cruz, Bergman, & Goran, 2002; Daniels, Morrison, Sprecher, Khoury, & Kimball, 1999; Freedman, Dietz, Srinivasan, & Berenson, 1999; Goran, Bergman, Cruz, & Watanabe, 2002; Gutin et al., 1990; Klish, 2006). The effects of childhood and adolescent overweight are already being felt as metabolic syndrome has already been found in approximately 4% of U.S. adolescents and diseases usually considered adult conditions (e.g., type-2 diabetes) are now commonly found in overweight children and adolescents (Cook, Weitzman, Auinger, Nguyen, & Dietz, 2003; Klish, 2006).

There is also the potential for long-term health effects because overweight children can potentially become overweight adults depending on age, severity of overweight, and parental obesity (S. S. Guo, Roche, Chumlea, Gardner, & Siervogel, 1994; Klish, 2006; Power, Lake, & Cole, 1997; Reilly et al., 2003; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). These consequences continue to place them at an increased risk for adverse health outcomes, including type-2 diabetes and cardiovascular disease (Abraham, Collins, & Nordsieck, 1971; DiPietro, Mossberg, & Stunkard, 1994; Nieto, Szklo, & Comstock, 1992; Serdula et al., 1993). These findings raise serious concerns about the health burden that childhood and adolescent overweight will have, not only in the short-term, but in the long-term as well.

CHAPTER 3
METHODS

3.1 Data

The data used in this study are a pooled cross section of adolescents, 12-19 years of age, taken from the National Health and Nutrition Examination Survey (NHANES) 1999-2002, which is coordinated by the CDC's National Center for Health Statistics. These data are a nationally representative, complex, multistage probability sample of the U.S. civilian non-institutionalized population. The NHANES consists of a household interview and a Mobile Examination Center (MEC) component. The data were collected in a nested fashion, therefore, a non-response adjustment and post-stratification was applied to each nested level. The NHANES 1999-2002 provides final interview and examination weights for the estimation of unbiased nationally representative parameter estimates and variance for each two year data release and for a combined four year dataset (CDC, 2004b). A complete description of the design, data collection, and analytic guidelines can be found elsewhere (CDC, 2006a).

The four year dataset (1999-2002) contains a total of 21,004 observations from the household interview and 19,759 from the MEC sub-sample. Roughly equal numbers of respondents were found in the 1999-2000 and the 2001-2002 data releases. The NHANES over sampled Mexican Americans; the 6,170 respondents comprise roughly 29 percent of the total sample. In addition, approximately 51% of all respondents are under the age of 20.

Respondents had the right to skip any question they did not want to answer. If a question was skipped it was coded as "refused". For many of the interview questions the respondent was given the option to answer "don't know". In this dataset variables with refusals or "don't know" were minimal and, where they did occur, they were very few observations associated with them. This is probably due to the data cleaning efforts by NHANES staff prior to making the data publicly available. Therefore, observations that were associated with either of these two categories were recoded as missing. The final analytic sample was restricted to adolescents with reported fasting plasma glucose levels; not taking insulin or oral hypoglycemic agents, and not pregnant. Application of these criteria resulted in a total of 2002 observations.

3.2 Measures

3.2.1 Metabolic Syndrome

This main outcome variable was metabolic syndrome. In 2002 the National Cholesterol Education Program (NCEP) Expert Panel-Adult Treatment Panel III released their final report in which they published a consensus definition of metabolic syndrome for adults. In 2003, the NCEP definition was modified for use in pediatric populations by Cook and colleagues (Cook, Weitzman, Auinger, Nguyen, & Dietz, 2003). This study uses Cook's modified definition of metabolic syndrome, defined as three or more of the following five criteria occurring simultaneously within an adolescent:

- elevated triglycerides (≥110 mg/dl)
- low HDL cholesterol (≤40 mg/dl)
- abdominal overweight (waist circumference ≥90^{th} percentile, cm)

- elevated fasting plasma glucose (≥110 mg/dl)
- elevated blood pressure (≥90th percentile, mm Hg).

A dichotomous variable was created identifying anyone with three or more of the above criteria as having metabolic syndrome.

The five metabolic syndrome criteria were measured objectively in all NHANES respondents, 12 years and older, during the MEC component. Those who were randomly assigned to the MEC morning session were eligible to have their triglycerides and fasting plasma glucose level measured if they fasted for at least eight hours, but less than 24 hours. In our sample, the 90th percentile by age and gender was used to determine waist circumference. This was used as a proxy for abdominal overweight. All eligible respondents had at least three systolic and diastolic blood pressure measurements taken using a mercury sphygmomanometer. The value at which elevated blood pressure is diagnosed in adolescents varies by age, gender, and height percentile.

The average blood pressure reading was used to determine elevated blood pressure by age, gender, and height percentile according to guidelines created by the National High Blood Pressure Education Program Working Group on High Blood Pressure in Children and Adolescents ("The fourth report on the diagnosis, evaluation, and treatment of high blood pressure in children and adolescents", 2004). Adolescent growth charts created by the Centers for Disease Control and prevention were used to calculate the appropriate height in centimeters corresponding to a given percentile (CDC, 2000). For example, if a 13-year old boy’s height is between the 25th-50th percentile (148.1cm-153cm) then his blood pressure would need to be at least 120/76 to be considered elevated.

3.2.2 Acculturation

The questions used to measure acculturation in NHANES are from the Short Acculturation Scale for Hispanics. This scale was developed by Marin and colleagues as an acculturation scale that could be used with any Latino subgroup, including Mexican Americans (Marin, Sabogal, Marin, Otero-Sabogal, & Perez-Stable, 1987). This is accomplished via 12 items that are designed to measure contact and participation with the dominant or non-dominant culture, media preference, and ethnic identity. Contact with the dominant and non-dominant cultures was measured using five language-based items. These five items asked respondents to identify the degree of Spanish/English use in different situations (i.e., when reading/speaking, used as a child, used at home, when thinking, or with friends).

Three items assess the language preference in media (i.e., in television, radio, and in general) and four items assess ethnic identity (i.e., who are your close friends, types of social gatherings, who you visit, and who do you want your children to interact with). The first two domains (contact with cultures and media preferences) were measured using a five-point Likert scale where a one denotes Spanish only, three is bilingual, and five is English only. The last domain, ethnic identity, also used a five-point Likert scale where a one was Latinos only, three was about half Latino and half American, and a five denotes Americans only. All the items in the Short Acculturation Scale for Hispanics originated from existing acculturation scales such as the ARSMA (Cuellar, Harris, & Jasso, 1980; Marin, Sabogal, Marin, Otero-Sabogal, & Perez-Stable, 1987; Padilla, 1980; Szapocznik, Scopetta, Kurtines, & de los Angeles Aranalde, 1978). Thus it should not be a surprise that the Short

Acculturation Scale for Hispanics (SAS) is similar to other acculturation scales in several respects.

According to Marin and colleagues, the reliability of the SAS was high, with a reported alpha coefficient of 0.92 (Marin, Sabogal, Marin, Otero-Sabogal, & Perez-Stable, 1987). The reliability of the SAS is similar to the 0.88 alpha coefficient reported for the ARSMA. The validity of the SAS was also similar to the ARSMA with respect to generational status. The SAS had a correlation coefficient of 0.65 and the ARSMA a correlation coefficient of 0.62.

Marin and colleagues also found that the reliability and validity coefficients of the five language questions, which measured contact and participation in the dominant and non-dominant cultures, were almost the same as those from the entire 12-item scale. These five questions also explained 55% of the scale's variance (Marin, Sabogal, Marin, Otero-Sabogal, & Perez-Stable, 1987). There is precedent for language to explain a large portion of an acculturation scale's total variance. In the ARSMA it was reported that the language factor explained 65% of the total variance (Cuellar, Harris, & Jasso, 1980). Marin and colleagues concluded that the five language-based questions constiture a valid and reliable short acculturation scale when used in a large study where acculturation is one of many measures. In addition, the five language items were also found to have almost identical validity in Mexican Americans as the whole 12-point scale (Marin, Sabogal, Marin, Otero-Sabogal, & Perez-Stable, 1987). Thus, these five language-based items were included as a valid and reliable means of measuring acculturation among Mexican Americans in the nationally representative NHANES 1999-2002.

The acculturation section is part of the NHANES household interview and includes five language-based questions used to assess acculturation. Non-Latino respondents were not eligible for these questions; only Latinos at least 12 years old were eligible. This sampling restriction accounts for the smaller number of observations found in the language-based acculturation questions.

The five language-based questions provided in NHANES to assess acculturation (Table 3.1) were scored on a five point Likert scale—speak only Spanish, more Spanish than English, both equally, more English than Spanish, and only English—with "don't know" giving respondents a sixth choice. Factor analysis was performed on the five language variables if respondents identified themselves as Mexican American. The variables strongly loaded to a single factor (eigenvalue=3.6); no other factors had an eigenvalue greater than one confirming the high correlation of the language questions. After confirming that the language variables all loaded to a single factor, the score procedure was used to create a continuous variable based on the factor loadings. This continuous acculturation variable was used in the regression analysis.

Table 3.1 Language-based acculturation variables

NHANES question
In general, what language(s) do you read and speak?
What was the language(s) you used as a child?
What language(s) do you usually speak at home?
In which language(s) do you usually think?
What language(s) do you usually speak with friends?

A dichotomous variable based on the five language variables above was also created. This was done in order to create a measure of low and high acculturation status for use exclusively in the bivariate analysis. If respondents placed more emphasis on using or understanding Spanish as well as or better than English (Likert score of ≤3) then they were classified as having a low level of acculturation.

3.2.3 Physical Activity

Four self-reported measures were used to describe physical activity during the past 30 days: the total number, frequency, duration, and intensity of physical activities. The physical activities reported are mostly considered leisure time activities, but everyday and household activities were also included. Respondents reported 48 commonly performed physical activities, such as various sports, pushups/sit-ups, walking, and yard work. For each physical activity that was reported the respondent gave the number of times the activity was performed. Frequency of physical activity represents the total number of times that any type of physical activity was performed during the last 30 days. Likewise, the duration for each physical activity (in minutes) was reported and the total time spent on all reported physical activity was calculated. Each physical activity reported was assigned a metabolic equivalent (MET) score—on a scale of 1 to 10—by NHANES staff according to established guidelines found in the *Compendium of physical activities: an update of activity codes and MET intensities* (Ainsworth et al., 2000).

Eleven variables were created from this basic set of physical activity measures. A dichotomous variable describing those with no reported physical activity versus those with any reported physical activity was generated. Categories (low, medium, and high) were created to facilitate comparison of the number, frequency, and duration of reported physical activities. No guidelines were found in the literature recommending the number of different physical activities that adolescents should perform, but there are recommendations published for the frequency, duration, and intensity of physical activity (Sallis & Patrick, 1994; US

Department of Health and Human Services, 2005). Due to the absence of specific guidelines for the number of physical activities adolescents should perform, thresholds for three proposed categories were developed by examining the data for natural cut-points. Adolescents that performed one or two types of physical activity within the last 30 days were classified as having low variability in their physical activity. Those reporting three or four activities were classified as having a moderate number of physical activities and adolescents with greater than four reported activities were classified as participating in a high number of activities.

The frequency and duration cut-points were based on published physical activity guidelines from a multinational expert committee and from Healthy People 2010 (Sallis & Patrick, 1994; US Department of Health and Human Services, 2005). The guidelines recommend that adolescents be active on a daily or nearly daily basis. Based on this, adolescents who performed physical activity less than every other day (i.e., performed physical activity less than 15 times in the last 30 days) were classified as having a low frequency of physical activity. Those that performed physical activity on a daily basis to every other day were classified as medium frequency level and high frequency was defined as adolescents reporting more than one session of physical activity per day (i.e., participated in physical activity >30 times in the last 30 days).

For the duration of physical activity, the guidelines recommend that adolescents perform physical activity for 20-60 minutes per session. Based on the Healthy People 2010 guidelines three sessions of physical activity per week was chosen as a means of calculating whether or not the adolescents performed their physical activities for a sufficient duration during the last month. In order to calculate the duration of physical activity/month three sessions of physical activity at 20 minutes a piece to obtain the total minutes of physical activity per week (60 minutes). That number was then multiplied by four (assuming four weeks/month) to obtain the minimum time the adolescent should have engaged in physical activity. Thus, if adolescents performed physical activity for less than 240 minutes in the last 30 days (3×20minutes=60×4weeks=240 minutes) they were classified as having low duration of physical activity. Medium duration was classified as greater than 240 minutes or less than or equal to 720 minutes (based on 3 sessions of physical activity/week at 60 minutes each) during the last 30 days. If an adolescent exceeded 720 minutes of physical activities they were classified as having a high duration of physical activity. Finally, the intensity of each physical activity was determined by their metabolic equivalent (MET) score. The scores for all reported physical activities over the last 30 days were averaged. Vigorous physical activity was defined as any activity with an average MET score greater than six and moderate physical activity was assigned a score of 3-6, which is consistent with guidelines in the *Compendium of physical activities: an update of activity codes and MET intensities* (Ainsworth et al., 2000). A dichotomous variable capturing vigorous versus moderate intensity was created based on the criteria above.

3.2.4 Diet

All nutritional intake variables were self-reported and collected during the MEC portion of NHANES. The interviewer asked respondents what foods and beverages they consumed in the previous 24 hours. For the 24 hour recalls performed during 1999-2000 the nutritional content of the reported foods and beverages was based on the University of Texas Food Intake Analysis System in conjunction with the USDA 1994-98 Survey Nutrient

Database. However, in 2002, NHANES was merged with USDA's Continuing Survey of Food Intakes by Individuals (CFSII).

This new national dietary survey is collected as part of NHANES and is called *What We Eat in America* (CDC, 2004a). As with the Texas Food Intake Analysis System, this new dietary survey also uses the USDA's Survey Nutrient Database (now called "USDA Food and Nutrient Database for Dietary Studies") to assign nutritional value to foods and beverages. As a result of this change the 2001 data were collected using the Texas Food Intake Analysis System and beginning in 2002 the new *What We Eat in America* survey was begun. Documentation from NHANES states that the collection and processing of the data were similar for 2001-2002 (CDC, 2004a).

Dietary variables included in this study include the number of different types of foods eaten, total energy in kilocalories (kcal), grams (gm) of protein, carbohydrates (gm), dietary fiber (gm), total fat (gm), saturated fatty acids (gm), monounsaturated fatty acids (gm), polyunsaturated fatty acids (gm), and cholesterol in milligrams (mg) were used in our study. The USDA food pyramid recommends servings from the different food groups, but it does not indicate how many different types of foods should be eaten as part of a balanced diet. Therefore, to establish a reasonable division of the consumption of the number of types of foods the data were examined for intuitive cut points. Those who ate eight or fewer types of food in 24 hours were labeled as eating a low variety of foods and adolescents eating greater than eight types of food served as the comparison. In addition to the dietary variables above as part of the MEC portion of NHANES there were some dietary variables collected during the household interview. Respondents self-reported the number of times meals were eaten at restaurants per week. A continuous variable describing the number of times restaurant food was eaten per week was created. A dichotomous variable showing those who ate outside the home at least once/week was also created.

3.2.5 Demographics

Race/ethnicity, age, and gender were self-reported. Race/ethnicity reported in NHANES included Mexican American, non-Latino White, non-Latino Black, other Latino, and other race. Only those respondents who categorized themselves as Mexican American, non-Latino Black (will be referred to as African American), and non-Latino White (will be referred to as Caucasian) were included in the analysis. Dichotomous variables for these three racial/ethnic groups were created.

Not including the “other Latino” (80 obs.) and “other race” (91 obs.) categories lead exclusion of 171 observations. Observations in these two categories were not included because there was no documentation listing which Latino subgroups or race they represented. Even if the subgroups were known there would be insufficient observations for a meaningful subgroup analysis. Since they were not over sampled any analysis performed on the “other Latino” or “other race” variables could not be extrapolated to the national level. These exclusions yielded 1831 observations in the race/ethnicity variables.

Data on the place of birth of the respondent and each of the respondent’s parents was also available. For adolescents and both their parents, dichotomous variables were created to distinguish whether they were born in the U.S. or if they were foreign born. The variable describing an adolescent’s place of birth (U.S. born) was part of the standard demographic questions all respondents were asked during the NHANES household interview. This was not the case for the parental origin questions. These questions were part of the NHANES section on acculturation, which was restricted only to Latino respondents. This sampling restriction accounts for the lower number of observations in these variables, similar to that seen in acculturation questions. The NHANES publicly released data does not contain information about how long Latinos have lived in the United States. There is a question asking what year an immigrant came to live in the U.S., but this information can only be accessed, in residence, at the National Center for Health Statistics Research Data Center and was not able to be included in this analysis.

Age was reported in years, and gender was coded dichotomously with female as the reference group. Body measurements were obtained during the MEC portion of NHANES. A respondent's height and weight were measured by a trained interviewer and used to generate a Body Mass Index (BMI) by NHANES staff. Based on the 2000 CDC growth charts three BMI categories were generated—normal weight (<85^{th} percentile), at risk for overweight (≥85^{th} and <95^{th} percentile), and overweight (≥95^{th} percentile) (Himes & Dietz, 1994).

3.3 Statistical Analysis

3.3.1 Aim 1: Examine the prevalence of metabolic syndrome, physical activity, dietary intake, and overweight between Mexican Americans and non-Latinos

To date, metabolic syndrome has been found almost exclusively in adults. The last two decades have seen an increased trend toward adolescent, as well as adult overweight. During the last few years metabolic syndrome has been found in adolescents and Mexican-American adolescents were found to have the highest prevalence. The first specific aim of this study will examine the prevalence of metabolic syndrome in adolescents. This will help determine if the gap in the prevalence of metabolic syndrome between Mexican Americans and other adolescents is shrinking or widening. Using survey commands in Stata 8 to account for the complex survey design, the mean of the dichotomous metabolic syndrome variable was estimated. This was interpreted as the percentage of U.S. adolescents with metabolic syndrome. The prevalence of the five criteria defining metabolic syndrome was assessed among those adolescents with metabolic syndrome (i.e., elevated triglycerides, low HDL, abdominal adiposity, elevated fasting plasma glucose, and elevated blood pressure).

The prevalence of metabolic syndrome was also examined by selected demographic characteristics (race/ethnicity, gender, BMI, country of origin, age), physical activity, and diet. The means for the dichotomous variables (no physical activity vs. any physical activity and vigorous vs. moderate intensity) were calculated in order to examine whether physical activity is associated with the prevalence of metabolic syndrome. The means for the number of activities performed, the frequency, and duration were also calculated based on a low, medium, and high level of these variables. The means were tested to see if there was a difference in the means associated with the prevalence of metabolic syndrome using a Pearson χ^2 test with the Rao and Scott second-order correction in order to compensate for the complex survey design adjustment (Rao & Scott, 1984; Stata, 2003). The same χ^2 test was done for race/ethnicity (Mexican American, African American, and Caucasian), gender, BMI (overweight, at risk for overweight, and normal), country of origin (U.S. vs. foreign born), and age. The dietary variables of food variability (low and high) and the number of times at a restaurant at least once/week were also examined as described above. The other dietary variables were tested using a *t*-test because they were continuous in nature. These included intake of energy (kcal), protein (gm), carbohydrate (gm), fiber (gm), total fat (gm), saturated fatty acids (gm), monounsaturated fatty acids (gm), polyunsaturated fatty acids (gm), and cholesterol (mg).

These set of bivariate analyses will help examine whether the hypothesized increased prevalence of metabolic syndrome and overweight exists in Mexican-American adolescents compared to non-Latino adolescents. As well as a hypothesized lower rate of physical activity and less healthy dietary intake among Mexican-American adolescents compared to non-Latino adolescents. The rate of physical activity, dietary intake, and BMI were compared between Mexican American and non-Latino adolescents using the variables and significance tests described above. These variables were also compared for males and females to see if gender is associated with the rate of physical activity, dietary intake, or overweight.

The association between race/ethnicity and metabolic syndrome was also explored using a logistic regression model (equation 1) in order to control for other factors that may be associated with metabolic syndrome and reflected in any bivariate association.

1) $$\Pr(\textit{metabolic syndrome} = 1) = f(\beta_0 + \beta_1 \textit{MexAm} + \beta_2 \textit{AfrAm} + \gamma \textit{Controls})$$

where f(·) is the logit function $\frac{1}{1+e^{-X_i\beta}}$

The dependent variable will be the dichotomous metabolic syndrome variable. Race/ethnicity is the main construct being evaluated. Dichotomous variables representing Mexican American ethnicity and African-American race are included as the main independent variables. These were compared to the Caucasian reference group. Control variables included gender, age, energy (kcal) intake, physical activity, and BMI. All control variables were continuous except physical activity which was dichotomous (no physical activity vs. any physical activity). A Wald test was used in all logistic regression models to test for statistical significance of the parameter estimates.

The association of race/ethnicity with physical activity and dietary intake was also evaluated to see if Mexican-American adolescents exhibited the hypothesized lower rate of physical activity and less healthy dietary intake compared to non-Latino adolescents. Examining the association of race/ethnicity on physical activity was accomplished using a combination of one logistic and four OLS regression models. The association between race/ethnicity and dietary intake was accomplished using only an OLS framework.

The dependent variable for the logistic regression is the dichotomous no physical activity versus any physical activity variable (equation 2). Because this variable is dichotomous, a logistic regression model was used. The main independent variables were Mexican American, and African American race/ethnicity using Caucasian as the reference group. Control variables included male, age, energy intake, and BMI. The other four physical

2) $\Pr(\textit{no physical activity} = 1) = f(\beta_0 + \beta_1 MexAm + \beta_2 AfrAm + \gamma Controls)$

activity measures (number, frequency, duration, and intensity of physical activities) were continuous so an OLS framework was used (equation 3). Each of these variables served as a dependent variable (PA_i) with race/ethnicity as the main independent variables and control variables as described above. The eleven dietary intake variables were also used as dependent variables in OLS models. Again, the main independent variables were the dichotomous race/ethnicity variables described above. Control variables for the dietary models included gender, age, no physical activity, and BMI. For these and all other OLS models, a *t*-test was used to determine the statistical significance of the parameter estimates.

3) $PA_i = (\beta_0 + \beta_1 MexAm + \beta_2 AfrAm + \gamma Controls + \mu_i)$

3.3.2 Aim 2: Examine the association of physical activity and diet with metabolic syndrome

The second aim proposes to examine the association between physical activity and dietary intake with metabolic syndrome. It is hypothesized that less physical activity performed and a less healthy diet are associated with a greater probability of developing metabolic syndrome. These hypotheses will be examined using logistic regression.

4) $\quad \Pr(\textit{metabolic syndrome} = 1) = f(\beta_0 + \beta_1 PA + \gamma Controls)$

The dichotomous metabolic syndrome variable was the dependent variable. The association between physical activity and metabolic syndrome was examined with five separate logistic models (equation 4). Each model was identical except for the main independent variables, which were the five physical activity measures of no physical activity vs. any physical activity, total number, total frequency, total duration, and average intensity of physical activities performed (PA). Control variables for all five of these models included race/ethnicity, gender, age, BMI and energy intake. This approach was taken due for two reasons. The first is a concern regarding multicollinearity. Correlations between most of the physical activity measures ranged from 0.36 – 0.97. The second reason is the potential for low variability in the metabolic syndrome variable. Thus, the models were constructed in a way to minimize the number of explanatory variables.

5) $\quad \Pr(\textit{metabolic syndrome} = 1) = f(\beta_0 + \beta_1 Diet + \gamma Controls)$

The same approach was employed when examining the association of diet with metabolic syndrome. Eleven logistic regression models were run with metabolic syndrome as the dependent variable and where the only difference was the dietary variable that served as the main independent variable of interest (equation 5). All the macronutrient variables were used one at a time as independent variables: number of foods, intake of energy, protein, carbohydrate, fiber, fat, saturated fat, monounsaturated fat, polyunsaturated fat, and the number of times restaurant food was eaten/wk (Diet). This was done for the same reasons cited above; correlation coefficients ranged from 0.1-0.97. Control variables in the eleven logistic models examining the association of dietary intake with metabolic syndrome included race/ethnicity, gender, age, BMI, and no physical activity vs. any physical activity.

3.3.3 Aim 3: Examine the association of acculturation on metabolic syndrome, physical activity, diet, and overweight

The third specific aim examined the association of acculturation with metabolic syndrome, physical activity, and dietary intake among Mexican-American adolescents. The working hypothesis is that higher levels of acculturation will be associated with increased overweight and a higher risk for metabolic syndrome. Logistic regression was used to explore the association of acculturation with metabolic syndrome (equation 6).

6) $\Pr(\textit{metabolic syndrome} = 1) = f(\beta_0 + \beta_1 \textit{Acculuration} + \gamma \textit{Controls})$

The main independent variable was the composite acculturation variable described earlier. Control variables included the mother's and father's country of origin, adolescent age, no physical activity vs. any physical activity, energy intake, and BMI. Even though there are several physical activity and dietary variables in this study, only one of each was used as a control because the main variable of interest in these models is acculturation. The physical activity (none vs. any physical activity) and dietary variable (energy) chosen were done so because they represented indicators of overall physical activity and dietary intake. Overweight was examined using BMI as the dependent variable in an OLS regression model (equation 7). Acculturation was the main independent variable of interest and controls were the same as above, except for the obvious exclusion of BMI as a control variable.

7) $BMI_i = (\beta_0 + \beta_1 \textit{Acculuration} + \gamma \textit{Controls} + \mu_i)$

It was also hypothesized that Mexican-American adolescents with higher levels of acculturation would have lower rates of physical activity and less healthy dietary intake. A combination of logistic and OLS models were employed to examine these associations. As before, the physical activity measure (none vs. any) requires the use of a logistic framework when used as a dependent variable (equation 8). Acculturation was the main independent variable of interest and control variables included mother's and father's country of origin, gender, age, BMI, and energy intake. The other four physical activity variables (number, frequency, duration, and intensity of physical activity) were used as dependent variables (PA_i) in an OLS framework with the same explanatory variables listed above (equation 9).

8) Pr (*no physical activity* = 1) = $f\,(\beta_0 + \beta_1 Acculturation + \gamma Controls)$

9) $PA_i = (\beta_0 + \beta_1 Acculuration + \gamma Controls + \mu_i)$

OLS models were used to examine acculturation on dietary intake (equation 10). The ten dietary intake variables (number of foods, total energy, protein, carbohydrate, fiber, total fat, saturated fat, monounsaturated fat, polyunsaturated fat, and the number of times respondents ate restaurant food/wk) were used as dependent variables ($Diet_i$). The explanatory variables were the same as those listed above for the physical activity models with on difference. Instead of energy intake as a control these models controlled for physical activity (none vs. any).

10) $Diet_i = (\beta_0 + \beta_1 Acculuration + \gamma Controls + \mu_i)$

A sensitivity analysis was conducted to examine the metabolic syndrome definition. The analyses described above to calculate the prevalence of metabolic syndrome and the association of acculturation on metabolic syndrome were run again with the NCEP definition for metabolic syndrome. Even though this definition is meant to be used in adult populations some studies have employed this definition to evaluate metabolic syndrome in a pediatric population (Boney, Verma, Tucker, & Vohr, 2005; Goodman, Daniels, Morrison, Huang, &

Dolan, 2004; Rodriguez-Moran, Salazar-Vazquez, Violante, & Guerrero-Romero, 2004). The sensitivity analysis will be able to help us determine whether or not a modified definition is necessary when examining metabolic syndrome among adolescents.

3.4 Statistical Issues

The NHANES 1999-2002 requires that any estimates that are interpreted to the national level must use the correct sample weights, strata, and primary sampling unit (PSU) variables in order to obtain unbiased parameter and variance estimates. These variables were all provided in the public use NHANES files. It should be noted that the 1999-2000 data and the 2001-2002 data have sample weights that were based on different population estimates and are, by themselves, not compatible. This was a result of the 1999-2000 data collection occurring prior to the release of the 2000 census figures. The accompanying sample weights for 1999-2000 are not based on the 2000 census figures, but the 2001-2002 sample weights are. As a result the public use NHANES files contain corrected four-year sample weights for use when examining data from 1999-2002. This analysis employed the corrected four-year sample weights to obtain unbiased estimates.

According to the NHANES documentation, in order to protect the confidentiality of the data the real PSUs were not provided to users of the public use data set. Instead masked variance units (MVU) were provided. This analysis used the NHANES strata and MVU variables provided for variance estimation. The following is an excerpt from the NHANES analytic guidelines explaining how MVUs protected confidentiality while allowing for the correct estimation of variance.

> An alternate method for variance estimation that protects confidentiality and allows the use of “PSUs” was developed and is now the recommended approach for analysis

> on the ongoing and continuous NHANES. This method creates Masked Variance Units (MVUs) which can be used as if they were Pseudo-PSUs to estimate sampling errors [variance] (similar to past NHANES). The Pseudo-PSUs on the data file are not the "true" design PSUs. They are a collection of secondary sampling units aggregated into groups (called Masked Variance Units) for the purpose of variance estimation. They produce variance estimates that closely approximate the variances that would have been estimated using the "true" design variance estimates. These MVUs have been created for NHANES 1999-2000 and 2001-2002 and added to the demographic data files for both two-year periods. They can also be used for the combined four-year data set (CDC, 2004b).

For analyses involving the acculturation variable calculation of unbiased variance estimates was not possible because there was a problem with singleton PSUs in multiple strata. This does not allow for the Stata survey logistic command to produce parameter or variance estimates. As a result the acculturation-related results were not able to be extrapolated to the national level. It is sometimes possible to merge these strata in order to circumvent this problem, but it requires information about the strata being considered for merging. Since these data come from public use data files there was no information provided regarding the strata; thus, merging strata was not possible. Lastly, for all logistic regression models the Huber/White robust standard errors were employed.

3.5 Design Limitations

This study has good external validity owing to the nationally representative probability sample taken. Estimates produced for all the racial/ethnic groups used in this study can be interpreted in the context of the nation and not simply the sample at hand. In the case of Mexican Americans a strategy of over-sampling was employed to make the data collected for this group nationally representative. The quasi-experimental design employed here is appropriate because of the descriptive nature of the research questions investigated.

A weakness in this study results from the analysis pertaining to acculturation suffering from a singleton primary sampling unit (PSU) problem. This did not allow for these results to be interpreted at the national level. The measurement of metabolic syndrome in adolescents was not a result of consensus as it is in adults. The modified definition used in this study is based on the consensus definition, but it may still cause some concern for construct validity. Another measure that may have construct validity concerns is the acculturation measure. The measure used in this study is based on language. While many others have also used language to measure acculturation there is no agreement among researchers as to the appropriate way in which to determine acculturation status. It should be noted that the reason for using a measure of acculturation based solely on language is a limitation of the data set being used. This was the most feasible way in which acculturation could be measured using these data. As with any study using self-reported data from adolescents there is always a concern for the reliability of those data. Lastly, since these data are cross-sectional causality was unable to be inferred. Instead this study inferred associations between variables.

CHAPTER 4
RESULTS

4.1 Descriptive Results

After excluding the "other Latino and "other race" categories there were 1,831 observations for the race and ethnicity variable. They included 734 Mexican Americans, 584 African Americans, and 513 Caucasians; these numbers represent approximately 40%, 32%, and 28% of the sample, respectively (Table 4.1). Roughly equal percentages of both genders (52% male) were represented. The average BMI was 24 with about two-thirds (63%) of respondents having a normal weight ($<85^{th}$ percentile on the CDC BMI chart by age and gender); 17% were at risk for overweight ($\geq 85^{th}$ and $<95^{th}$ percentile); and 20% were overweight ($\geq 95^{th}$ percentile). The average age was 15 years and each age had fairly equal representation (11.5%-14% of sample/age). In the sample approximately four-fifths (85%) of adolescents were U.S. born.

Approximately 5% (102 obs.) of the adolescents in our sample met the definition for having metabolic syndrome and 16% had at least two of the five traits. The most common metabolic syndrome traits in our sample were elevated triglycerides (22%) and low HDL cholesterol (22%). The other three traits were found in 11% or less of adolescents; abdominal adiposity (waist circumference) (11%), elevated fasting plasma glucose (2%), and elevated blood pressure (7%).

Approximately 19% of adolescents reported not participating in any physical activity. On average, about two types of physical activities were performed by adolescents in the last 30 days. Among those who reported some physical activity, the majority (45%) reported a low number of activities while a quarter took part in a moderate number and 12% reported a high number. Overall, physical activity was performed slightly more than once per day in the last month with 22% and 23% of adolescents performing activities with a low and moderate frequency, respectively. A high frequency of activity was reported by 37% of the sample.

Table 4.1 Sample Characteristics: Descriptive Results

Variable Description	Obs	Mean	Std. Dev.	Min	Max
Demographics					
Mexican American	1831	0.40	0.49	0	1
African American	1831	0.32	0.47	0	1
Caucasian	1831	0.28	0.45	0	1
Male	1831	0.52	0.50	0	1
BMI	1814	23.63	5.75	13.72	56.64
Normal BMI (<85th percentile)	1814	0.63	0.48	0	1
At risk BMI (≥85th and <95th percentile)	1814	0.17	0.37	0	1
Overweight BMI (≥95th percentile)	1814	0.20	0.40	0	1
Age	1831	15.39	2.31	12	19
U.S. born	1825	0.85	0.36	0	1
Metabolic Syndrome and Traits					
Metabolic syndrome (≥3 traits)	1831	0.05	0.22	0	1
Triglycerides (mg/dl)	1808	0.22	0.42	0	1
HDL (mg/dl)	1804	0.22	0.41	0	1
Abdominal adiposity$^{\omega}$	1810	0.11	0.31	0	1
Fasting plasma glucose (mg/dl)	1831	0.02	0.15	0	1
Blood pressure (mmHg)	1831	0.07	0.26	0	1
Physical Activity					
No physical activity	1831	0.19	0.39	0	1
Total # of activities	1831	2.32	2.23	0	31
Low # of activities	1831	0.45	0.50	0	1
Moderate # of activities	1831	0.24	0.43	0	1
High # of activities	1831	0.12	0.33	0	1
Total frequency	1831	32.58	41.92	0	437
Low frequency	1831	0.22	0.41	0	1
Moderate frequency	1831	0.23	0.42	0	1
High frequency	1831	0.37	0.48	0	1
Total duration (min)	1831	127.01	151.56	0	1695
Low duration	1831	0.64	0.48	0	1
Moderate duration	1831	0.16	0.37	0	1
High duration	1831	0.01	0.09	0	1
Average MET	1492	6.64	1.60	2.5	10
Vigorous intensity	1488	0.63	0.48	0	1

NOTE: ω-measured using waist circumference (cm).

Table 4.1 Descriptive Results (cont.)

Variable Description	Obs	Mean	Std. Dev.	Min	Max
Diet					
Total # of foods eaten	1793	13.07	5.28	2	49
Low # of foods	1793	0.19	0.39	0	1
Energy (kcal)	1793	2310.27	1087.45	119.1	9605.76
Total Protein (gm)	1793	77.37	42.44	0	351.51
Total Carbohydrate (gm)	1793	313.10	153.38	22.4	1487.09
Total Fiber (gm)	1793	13.96	9.49	0	78.78
Total Fat (gm)	1793	84.22	47.01	0	382.99
Total saturated fatty acids (gm)	1793	29.00	17.08	0	129.37
Total monounsaturated fatty acids (gm)	1793	32.47	18.86	0	162.93
Total polyunsaturated fatty acids(gm)	1793	16.24	11.14	0	79.941
Total cholesterol (mg)	1793	258.93	225.18	0	1654
How many times ate restaurant food	1548	2.53	2.25	0	21
Ate at a restaurant at least once/week	1548	0.91	0.29	0	1
Acculturation (Only Mexican Americans)					
Acculturation (composite)	714	0.00	0.96	−1.93	1.25
Low acculturation	714	0.27	0.44	0	1
Language(s) read and spoken	732	3.52	1.14	1	5
Language(s) used as child	733	2.65	1.66	1	5
Language(s) spoken at home	733	3.16	1.49	1	5
Language(s) used to think	714	3.73	1.39	1	5
Language(s) used with friends	731	3.83	1.29	1	5
Mother U.S. born	732	0.36	0.48	0	1
Father U.S. born	727	0.33	0.47	0	1

On average, the total duration of all physical activities was 127 minutes during the last month or approximately four minutes a day. A majority (64%) was rated as performing physical activity for a low duration, 16% for a moderate duration, and only one percent performed physical activity for a high duration of time. On the 10 point MET scale, the average intensity level used to perform physical activity was about 6.5, which corresponds to a vigorous intensity level, among those that reported any physical activity. More than half (63%) of adolescents exerted themselves at a vigorous level when performing physical activities.

Examining the dietary habits of our sample reveals that on average 13 types of food were consumed in a 24 hour period with 19% eating ≤8 foods per day. The average energy intake was 2310 kcal. Protein intake averaged 77 gm/day, 313 gm/day of carbohydrates were consumed, and dietary fiber averaged 14 gm/day. The total fat intake was an average of 84 gm/day with saturated, monounsaturated, and polyunsaturated fatty acids averaging 29 gm/day, 32 gm/day, and 16 gm/day, respectively. Cholesterol intake averaged 259 mg/day. On a weekly basis, adolescents ate in restaurants an average of 2.5 times with the majority (91%) eating at a restaurant at least once per week.

The following descriptive statistics pertain only to the Mexican American sub-sample because these items were restricted to Latinos in NHANES. The composite acculturation variable has a mean of zero and ranges from −1.93 to 1.25. According to the dichotomous acculturation variable, 27% of Mexican-American adolescents had a low level of acculturation. On average, Mexican-American adolescents reported using English as much as or slightly more than Spanish (Likert score >3) when they read or speak, speak at home, think, and converse with their friends. When the adolescents were children they reported speaking Spanish more often than English (Likert score <3). Most of the parents of Mexican-American adolescents were born outside the U.S.; only 36% of mothers and 33% of fathers were born in the United States.

4.2 AIM 1: Examine the prevalence of metabolic syndrome, physical activity, dietary intake, and overweight between Mexican Americans and non-Latinos

4.2.1 Prevalence of Metabolic Syndrome among U.S. adolescents

Adjusting for the complex survey design, metabolic syndrome is present in 4.8% of the U.S. adolescent population (Table 4.2). Among those with metabolic syndrome the most common trait was abdominal adiposity (~44%) followed by elevated plasma glucose levels

(30%) and elevated blood pressure (27%). Elevated triglycerides and low HDL were present in about 18% of cases.

Table 4.2 Prevalence of metabolic syndrome and associated traits among U.S. adolescents

Variable Description	% of Subjects with Metabolic Syndrome
Total in U.S.	4.8
Metabolic Syndrome traits	
Elevated triglycerides (mg/dl)	18.6
Low HDL (mg/dl)	18.3
Abdominal adiposity$^{\omega}$	44.5
Elevated fasting plasma glucose (mg/dl)	30.0
Elevated blood pressure (mmHg)	27.0

NOTE: ω-measured using waist circumference (cm).

According to bivariate analysis, a sedentary lifestyle was significantly associated with metabolic syndrome. Those who did not participate in any physical activity were more than twice as likely to have metabolic syndrome compared to adolescents who performed some physical activity (9% vs. 4.1%, p=0.004). The number (p=0.04) and duration (p=0.03) of physical activity were also significantly associated with metabolic syndrome. The frequency and intensity of physical activity were not statistically significant, but the frequency of physical activity was near significance (p=0.05). Adolescents with a low variety of foods (≤8/day) in their diet had a significantly higher prevalence of metabolic syndrome (7.7% vs. 3.5%, p=0.047) compared to those with more variety in their diet. However, none of the macronutrient intake variables (energy, protein, carbohydrate, fiber, total fat, saturated, monounsaturated, polyunsaturated fat, cholesterol, and the number of times restaurant food per week was eaten, were significantly associated with metabolic syndrome.

Several demographic characteristics were also associated with metabolic syndrome. Race and ethnicity was significantly associated with metabolic syndrome (p=0.03). Adolescents of Mexican American ethnicity were the most likely (7.8%) to have metabolic syndrome compared to African Americans (3.0%) or Caucasians (5.0%), which confirms the hypothesis that Mexican Americans would have a higher prevalence of metabolic syndrome compared to non-Latinos. Males were more than twice as likely (6.6% vs. 2.9%, p=0.01) to have metabolic syndrome compared to females. Overweight (BMI $\geq 95^{th}$ percentile) was strongly associated with metabolic syndrome (25%, p <0.001), by contrast normal weight (BMI $<85^{th}$ percentile) was associated with a very low likelihood of having metabolic syndrome (0.02%). A statistically significant association was not found between age and country of origin (U.S. vs. foreign born) with metabolic syndrome. Due to singleton primary sampling units (PSU) within strata, acculturation and the parental origin variables were not able to be adjusted to reflect the U.S. population so they are not reported during this part of the analysis.

Table 4.3 shows four logistic regression models illustrating how the association of Mexican American ethnicity with metabolic syndrome is not as straightforward as the bivariate analysis made it seem. Model 1 shows the unadjusted effect of race and ethnicity on metabolic syndrome. This model shows Mexican Americans have a higher probability of having metabolic syndrome compared to Caucasians, which is in agreement with the bivariate results above. Models 2-4 represent models where controls are added to show their influence on the association of race/ethnicity and metabolic syndrome. In model 2 Mexican Americans still have an increased probability of having metabolic syndrome. However, when the model controls for energy intake and physical activity (model 3) the Mexican American coefficient is no longer significant. Model 4 is the full model which also controls for BMI. This addition reverses the sign on the Mexican American coefficient and it demonstrates that after controlling for primarily energy intake, physical activity, and BMI the effect of ethnicity on metabolic syndrome has disappeared.

Table 4.3 Logistic regression of race/ethnicity on metabolic syndrome among U.S. adolescents

Variable Definition	Metabolic Syndrome			
	(1)	(2)	(3)	(4)
Mexican American	0.471**	0.444**	0.301	−0.115
	(2.40)	(2.16)	(1.39)	(0.50)
African American	−0.528	−0.529	−0.739*	−2.910***
	(1.45)	(1.45)	(1.96)	(4.12)
Male		−0.022	−0.046	1.030**
		(0.40)	(0.82)	(2.51)
Age		0.877**	1.048***	−0.431***
		(2.43)	(2.85)	(4.99)
Energy (kcal)			−0.000	0.000
			(0.71)	(0.87)
No physical activity			1.210***	1.543***
			(3.82)	(3.37)
BMI				0.369***
				(11.58)
Constant	−2.938***	−3.128***	−2.760**	−7.540***
	(18.65)	(2.88)	(2.56)	(4.34)
Observations	1831	1831	1793	1782

NOTE: All estimates adjusted for the complex survey design. Absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

A sedentary lifestyle and BMI both contribute to an increased probability for having metabolic syndrome and seem to indicate an indirect effect of Mexican American ethnicity on metabolic syndrome. It is worth noting that age and gender are also significant in model 4, but when they were the only control variables (model 2) Mexican American ethnicity still significantly increased the probability of having metabolic syndrome. This suggests that age and gender should be considered when looking at metabolic syndrome, but Mexican American ethnicity is still significantly associated with metabolic syndrome when they are controlled for. The association of race and ethnicity with the individual metabolic syndrome traits was also examined. Mexican Americans were significantly less likely to have elevated blood pressure compared to Caucasians, but did not have a significant association with any other traits.

4.2.2 Variations in Physical Activity, Diet, and Overweight

Based on the bivariate results presented above, Mexican-American adolescents have the highest prevalence of metabolic syndrome. It may be that characteristics inherent to Mexican-American ethnicity or behavioral factors (e.g., physical activity and diet) may be mostly responsible. This is supported by the finding that physical activity and diet were found to be significantly associated with metabolic syndrome. They were also both associated with overweight, which was found to be strongly associated with an increased prevalence of metabolic syndrome. These results suggest that there may be inherent differences in physical activity, diet, and overweight between Mexican Americans and non-Latino racial groups that contribute to the higher prevalence of metabolic syndrome seen among Mexican-American adolescents.

Bivariate analysis shows that Mexican Americans (19% vs.13%, p <0.05) were more likely than non-Mexicans (African American and Caucasian) to lead a sedentary lifestyle. Mexican-American adolescents who reported physical activity were less likely to perform a high number of activities (11% vs. 17%, p <0.05). Mexican Americans were less likely to participate in activities with high frequency (34% vs. 42%, p <0.05) or of moderate duration (13% vs. 21%, p <0.05).

Multivariate analysis shows that there are differences in the physical activity and dietary habits of Mexican American and Caucasian adolescents. Using logistic regression, Mexican-American adolescents were more likely to be inactive compared to Caucasian adolescents (Table 4.4). OLS regressions of race/ethnicity on the continuous measures of physical activity corroborate this finding. On average, Mexican-American adolescents were found to perform fewer physical activities (−0.5/month), with less duration (−42 minutes/month), but with slightly greater intensity (0.4 MET/month) compared to Caucasians. Mexican American ethnicity was not significantly associated with the frequency that physical activity was performed.

Table 4.4 Regression analysis of race/ethnicity on physical activity in U.S. adolescents

Variable Description	No Physical Activity[φ]	# of PA	Frequency of PA	Duration of PA	Intensity of PA (MET)
Mexican	0.654***	−0.496***	−4.449	−42.045***	0.414***
American	(3.39)	(3.35)	(1.55)	(4.08)	(3.93)
African	0.928***	−0.757***	−3.492	−42.714***	0.234**
American	(4.81)	(4.56)	(0.96)	(3.37)	(2.05)
Male	−0.392**	0.299	5.777*	53.488***	0.464***
	(2.06)	(1.59)	(1.91)	(4.13)	(3.73)
Age	0.237***	0.040	−0.801	11.004***	−0.123***
	(5.24)	(1.08)	(1.33)	(4.52)	(4.30)
Energy (kcal)	−0.000	0.000**	0.001	0.009	0.000
	(1.21)	(2.38)	(0.98)	(1.18)	(1.33)
BMI	0.005	−0.015	−0.172	−0.600	−0.008
	(0.30)	(1.36)	(0.72)	(0.64)	(0.74)
Constant	−5.451***	1.984***	47.284***	−40.708	8.030***
	(7.01)	(3.79)	(4.25)	(1.32)	(16.44)
Observations	1782	1782	1782	1782	1462
R-squared	––	0.04	0.01	0.08	0.07

NOTE: φ Robust z statistics in parentheses. All other models show absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

There were few dietary measures that varied significantly by group. Mexican Americans took in less calories/day (2243 kcal vs. 2425 kcal, p <0.05), less carbohydrates/day (304 gm vs. 332 gm, p <0.05), and less saturated fatty acids (28 gm vs. 31 gm, p <0.05) compared to non-Mexicans. Mexican-American adolescents were found to have lower rates of physical activity that may contribute to overweight; however, Mexican Americans seem to have a slightly healthier dietary intake compared to non-Mexicans. These results may contribute to the finding that Mexican-American adolescents were more likely to be overweight (22% vs. 17%, $p < 0.05$) compared to non-Mexicans.

Table 4.5 shows OLS regression results of race/ethnicity on the 12 dietary measures used. Several of these dietary measures were found to differ between Mexican American and Caucasian adolescents. Mexican-American adolescents consumed fewer calories (−194 kcal/day), carbohydrates (−28 gm/day), and sugars (−17 gm/day) compared to Caucasians. Total fiber intake seems to be higher (+1 gm/day) in Mexican Americans, but this finding was only significant at the 10% level. No significant associations were found between Mexican American ethnicity and the number of foods consumed per day or the total protein intake per day.

The second half of Table 4.5 presents results of the various measures of fat intake, cholesterol, and the number of times restaurant food was eaten. Mexican Americans consumed less total fat (−6 gm/day), saturated fat (−3 gm/day), monounsaturated fat (−2 gm/day), and ate less restaurant food (−0.5 times/wk) compared to Caucasian adolescents, on average. No significant differences between Mexican Americans and Caucasians were found when examining total polyunsaturated fat and total cholesterol intake per day.

Table 4.5 OLS regression of race/ethnicity on diet in U.S. adolescents

Variable Description	Number of foods	Total Energy	Total Protein	Total Carbohydrate	Total Sugars	Total Fiber
Mexican American	−0.256 (0.63)	−194.082*** (4.27)	−2.799 (1.07)	−28.356*** (3.93)	−17.715*** (2.96)	1.016* (1.78)
African American	−1.383*** (4.61)	−129.539** (2.22)	−5.150* (1.85)	−22.952** (2.35)	−11.079 (1.24)	−2.024*** (3.79)
Male	−0.055 (0.14)	738.049*** (8.41)	30.382*** (7.76)	86.262*** (7.75)	52.118*** (4.59)	3.380*** (5.19)
Age	0.265*** (3.17)	108.070*** (6.25)	3.479*** (6.56)	12.784*** (4.78)	10.227*** (3.01)	0.501*** (4.39)
No PA	−1.110* (1.79)	−160.908 (1.34)	−4.516 (1.40)	−30.614* (1.72)	−17.311 (1.36)	−2.081** (2.72)
BMI	−0.085*** (2.90)	−22.464*** (3.65)	−0.445** (2.07)	−3.583*** (3.62)	−1.999* (1.80)	−0.197*** (4.29)
Constant	11.731*** (8.27)	932.344*** (3.39)	21.842** (2.32)	179.230*** (4.69)	42.969 (1.07)	9.575*** (4.51)
Observations	1782	1782	1782	1782	905	1782
R-squared	0.03	0.17	0.15	0.13	0.12	0.08

NOTE: PA=Physical Activity. Absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Table 4.5 OLS regression of race/ethnicity on diet in U.S. adolescents (cont.)

Variable Description	Total Fat	Total Sat. fat	Total monounsat. fat	Total Polyunsat. fat	Total cholesterol	# of times ate restaurant food
Mexican American	−5.992** (2.37)	−2.984*** (2.98)	−2.103** (2.13)	−0.896 (1.51)	13.771 (0.64)	−0.525*** (3.12)
African American	−1.173 (0.42)	−1.282 (1.26)	0.541 (0.49)	−0.518 (0.71)	7.486 (0.45)	−0.203 (1.27)
Male	27.230*** (6.97)	10.079*** (5.98)	10.891*** (7.62)	3.924*** (5.24)	115.558*** (4.45)	0.355* (1.77)
Age	3.938*** (4.99)	1.286*** (4.56)	1.600*** (5.21)	0.749*** (3.70)	11.691*** (6.35)	0.251*** (5.94)
No PA	−2.910 (0.71)	−2.112 (1.56)	−0.272 (0.14)	−0.316 (0.39)	−7.970 (0.54)	0.102 (0.50)
BMI	−0.986*** (3.50)	−0.354*** (3.13)	−0.409*** (4.24)	−0.163** (2.12)	−0.732 (0.61)	−0.010 (0.85)
Constant	35.465** (2.60)	14.160*** (2.80)	12.374** (2.43)	6.887* (1.93)	28.390 (0.79)	−1.029 (1.68)
Observations	1782	1782	1782	1782	1782	1533
R-squared	0.12	0.12	0.12	0.06	0.08	0.06

NOTE: PA= Physical Activity, Sat.= Saturated, Monounsat.= Monounsaturated, Polyunsat.= Polyunsaturated. Absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

The hypothesized association that more Mexican-American adolescents would be overweight compared to non-Latino adolescents was also explored using OLS regression. On average, Mexican-American adolescents had a BMI score that was 1.3 points higher and African Americans had a BMI score 2 points higher compared to Caucasians. For example, the average BMI for a 15 year old Caucasian male is 21.8, which is just short of the 75th percentile. A 1.3 unit increase for a 15 year old Mexican-American male would equal 23.1, which is just short of the 85th percentile. In this example the Mexican-American adolescent is on the verge of becoming at risk for overweight while the Caucasian adolescent is still comfortably in the normal weight range. These findings link Mexican American ethnicity to the strongest risk factor for metabolic syndrome, overweight. Since ethnicity itself is not the likely reason for this association, it suggests that behavioral factors that Mexican-American adolescents engage in may be responsible. Previous results showing that Mexican-American adolescents were more likely to be sedentary seem to support this assertion.

4.3 Aim 2: Examine the association of physical activity and diet with metabolic syndrome

Logistic regression models were used to examine whether physical activity and dietary intake are associated with metabolic syndrome. It was hypothesized that lower rates of physical activity and a more unhealthy diet are associated with a higher likelihood of having metabolic syndrome. Results show that performing no physical activity versus performing any physical activity increases the probability of having metabolic syndrome (Table 4.6). Thus, for adolescents who perform no physical activity the odds of having metabolic syndrome are 4.7 times as large compared to adolescents who performed some physical activity. None of the other physical activity measures significantly affected the probability of having metabolic syndrome. In each of the five models, BMI was found to increase the probability of having metabolic syndrome. For a one unit increase in BMI the odds of having metabolic syndrome are 1.4 times larger than an adolescent with a lower BMI. The finding that BMI significantly affects the likelihood of having metabolic syndrome is not surprising taking into account that BMI was also found to increase the likelihood of having all five of the traits defining metabolic syndrome (elevated triglycerides, low HDL, abdominal adiposity, elevated fasting plasma glucose, and elevated blood pressure.

Table 4.6 Logistic regression of physical activity on metabolic syndrome in U.S. adolescents

Variable Description	Metabolic Syndrome
Physical Activity	
No physical activity	1.543***
	(3.37)
Demographics	
Mexican American	−0.115
	(0.50)
African American	−2.910***
	(4.12)
Male	1.030**
	(2.51)
Age	−0.431***
	(4.99)
BMI	0.369***
	(11.58)
Energy (kcal)	0.000
	(0.87)
Constant	−7.540***
	(4.34)
Observations	1782

NOTE: PA=Physical Activity. Absolute value of z statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Logistic regression was also used to explore whether dietary intake is a good predictor of metabolic syndrome. Each of the 12 dietary measures was used as the primary variable of interest in separate models. All measures were specific macronutrients (e.g., protein, carbohydrates, saturated fatty acids, etc.) except for the variability of foods eaten, energy intake (kcal), and the number of meals eaten at restaurants. Models using diet as the main independent variable controlled for the following: race/ethnicity (Caucasian used as reference group), gender, age, BMI, and a measure of inactive vs. physically active.

Results show that dietary intake did not seem to be significantly associated with the likelihood of having metabolic syndrome in adolescents. Bivariate analysis had previously shown that those with a low number of foods in their diet had a significantly higher prevalence of metabolic syndrome. This multivariate analysis demonstrates that the bivariate association does not hold after controlling for ethnicity, age, gender, physical activity and BMI. As seen above, BMI and physical inactivity both increase the probability of having metabolic syndrome.

Although diet was not found to be associated with metabolic syndrome several of the dietary measures were found to be significantly associated with several of the metabolic syndrome traits. The probability of elevated triglycerides and lower HDL increased slightly with higher intake of carbohydrates. Energy intake also slightly increased the probability of low HDL levels. The probability of abdominal adiposity increased with an increased frequency of eating meals outside the home. These results imply in conjunction with other factors (e.g., low rate of physical activity) dietary intake may contribute to the risk of developing metabolic syndrome.

4.4. Aim 3: Examine the association of acculturation on metabolic syndrome, physical activity, diet, and overweight

Bivariate results show twenty-seven percent of Mexican-American adolescents in the sample with a low level of acculturation (p <0.001) were born in the U.S. compared to those with high acculturation (73%). Males (59% vs. 48%, p <0.05) were more likely than females to have a low level of acculturation. Similarly, a small percentage of mothers (3.7% vs. 96.3%, p <0.001) and fathers (3.7% vs. 96.3%, p <0.001) of Mexican-American adolescents with low acculturation were born in the U.S. compared to parents of more acculturated adolescents. However, the parental associations between acculturation and country of birth did not hold in a multivariate analysis.

4.4.1 Acculturation and Metabolic Syndrome

Bivariate analysis did not show a significant association between acculturation and metabolic syndrome. Logistic regression models controlling for parental country of birth, gender, age, BMI, physical activity, and caloric intake (energy) also did not show that a higher level of acculturation significantly alters the probability of developing metabolic syndrome. BMI and a lack of physical activity were significantly associated with an increase in the probability of having metabolic syndrome (p<0.001). This is consistent with previous results.

4.4.2 Association of acculturation on physical activity, dietary intake, and overweight

Based on bivariate analysis, acculturation in Mexican-American adolescents was associated with less physical activity performed. Those with low acculturation were almost twice as likely to report no physical activity (30% vs. 16%, p <0.001) versus adolescents with a higher level of acculturation. Performing physical activities with a high frequency (25%, vs. 36%, p <0.05) and for a low duration (55% vs. 71%, p <0.001) was also less likely in those with low acculturation.

A logistic regression model was used to examine the effect of acculturation on those who reported no physical activity versus those who reported any physical activity (Table

4.7). The other measures of physical activity, the number, frequency, duration, and intensity were examined using an OLS framework. These models test the hypothesis that higher levels of acculturation would be associated with less physical activity performed among Mexican-American adolescents. Results show that higher levels of acculturation increase the level of physical activity performed. For example, higher levels of acculturation decrease the likelihood of being sedentary. Higher levels of acculturation also increased the number of physical activities performed (+0.4 activities/month), the frequency of physical activities (+5 bouts/month), and the duration of physical activities (+15 minutes/month). However, acculturation did not seem to significantly affect the intensity with which physical activity was performed nor did BMI have an association with physical activity except to decrease the intensity with which it was performed.

Table 4.7 Regression analysis of acculturation on physical activity in Mexican-American adolescents

Variable Description	No Physical Activity$^{\varphi}$	# of PA	Frequency of PA	Duration of PA	Intensity of PA (MET)
Acculturation$^{\psi}$	−0.433***	0.414***	4.941*	14.679*	−0.162
	(2.74)	(2.89)	(1.87)	(1.65)	(1.37)
Demographics					
Mother US born	0.179	0.130	2.189	9.478	0.046
	(0.43)	(0.44)	(0.40)	(0.51)	(0.19)
Father US born	0.030	−0.212	−2.299	6.908	−0.130
	(0.08)	(0.74)	(0.43)	(0.39)	(0.56)
Male	−0.546***	0.148	3.759	21.405*	0.532***
	(2.63)	(0.79)	(1.09)	(1.84)	(3.65)
Age	0.264***	0.007	0.172	10.501***	−0.142***
	(5.31)	(0.17)	(0.23)	(4.15)	(4.36)
BMI	0.003	−0.003	0.120	−0.351	−0.027**
	(0.17)	(0.15)	(0.39)	(0.34)	(2.08)
Energy (kcal)	−0.000	0.000*	0.002	0.011*	−0.000
	(0.28)	(1.71)	(1.39)	(1.93)	(0.02)
Constant	−5.520***	1.760**	17.773	−82.462*	9.347***
	(6.01)	(2.51)	(1.37)	(1.89)	(16.98)
Observations	689	689	689	689	560
R-squared	––	0.03	0.02	0.06	0.08

NOTE: ψ Not nationally representative. φ Robust z statistics in parentheses, all other models show absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Bivariate analysis did not show a significant association between acculturation and dietary intake. A low level of acculturation was associated with eating fewer meals (85% vs.92%, p <0.05) prepared at restaurants on a weekly basis, compared to Mexican-American adolescents with a higher level of acculturation. OLS results show that more acculturated adolescents seem to have a greater intake of macronutrients (Table 4.8). The following macronutrients increased among those with higher levels of acculturation; calories increased by 137 kcal/day, carbohydrate intake increased by 25gm/day, saturated fatty acids increased 2.3gm/day, and monounsaturated fatty acids increased 1.8 gm/day. With higher levels of acculturation the number of times that an adolescent ate meals outside the home also increased by 0.3 times/week. Higher levels of acculturation did not affect the number of foods eaten, intake of protein, fiber, total fat, polyunsaturated fat, or cholesterol.

Table 4.8 OLS regression of acculturation on diet in Mexican-American adolescents

Variable Description	Energy (kcal)	Total Carbohydrate	Total Sat. fat	Total monounsat. fat	# of times ate restaurant food
Acculturation$^{\psi}$	136.739**	24.901***	2.270**	1.766*	0.272**
	(2.35)	(3.03)	(2.42)	(1.74)	(2.17)
Demographics					
Mother US born	−195.672	−37.734**	−1.567	−1.618	0.388
	(1.62)	(2.22)	(0.81)	(0.77)	(1.51)
Father US born	62.798	8.360	−0.355	1.775	−0.185
	(0.54)	(0.51)	(0.19)	(0.87)	(0.74)
Male	568.214***	76.138***	7.169***	8.265***	0.022
	(7.78)	(7.37)	(6.09)	(6.47)	(0.14)
Age	68.724***	8.995***	0.583**	0.880***	0.290***
	(4.12)	(3.82)	(2.17)	(3.02)	(8.06)
BMI	−28.189***	−3.829***	−0.380***	−0.391***	−0.020
	(4.23)	(4.06)	(3.54)	(3.36)	(1.36)
No PA	−42.983	−15.022	−0.309	0.819	−0.037
	(0.44)	(1.10)	(0.20)	(0.48)	(0.18)
Constant	1,605.189***	228.660***	24.706***	22.373***	−1.867***
	(5.74)	(5.79)	(5.48)	(4.58)	(3.05)
Observations	689	689	689	689	604
R-squared	0.12	0.12	0.08	0.09	0.12

NOTE: ψ Not nationally representative. PA= Physical Activity. Absolute value of t statistics in parentheses. * significant at 10%; ** significant at 5%; *** significant at 1%

Bivariate analysis found overweight was less prevalent (16% vs. 24%, p <0.05) in Mexican-American adolescents with low acculturation compared to those with higher levels of acculturation. OLS results do not agree and instead show an insignificant association between acculturation and BMI. BMI did have an inverse association with dietary intake. As BMI increased the following macronutrients decreased: energy intake (−28 gm/day), protein (−0.8gm/day), carbohydrates (−3.8 gm/day), fiber (−0.22 gm/day), total fat (−1.1 gm/day), saturated fat (−0.4 gm/day), monounsaturated fat (−0.4 gm/day), and polyunsaturated fat (−0.2). It is also interesting to note that having a U.S. born mother reduces the carbohydrate intake of adolescents by 38gm/day and the fiber intake by 2.2gm/day. Compared to females, males saw an increase in all the dietary measures except for the number of foods eaten and the number of times they ate meals at restaurants.

4.5. Sensitivity Analysis

An analysis comparing the modified NCEP metabolic syndrome (MetS.) definition used in the analysis above compared to the NCEP consensus (NCEP MetS.) definition for adults, used by some to examine metabolic syndrome in adolescents, was performed. The results show a striking difference between the two definitions when applied to an adolescent population. As reported above, the MetS. definition identified 4.8% of all adolescents as having metabolic syndrome compared to 2.8% by the NCEP MetS. (p <0.001). The percentage of the individual metabolic syndrome traits also differed significantly (p <0.001) among those with metabolic syndrome. Under the NCEP MetS. definition there were more adolescents identified with elevated triglycerides (27.8% vs. 18.6%) compared to the MetS., but fewer with low HDL (7.3% vs. 18.3%), abdominal adiposity (20.2% vs. 44.5%), elevated fasting plasma glucose (21.3% vs. 30%) and elevated blood pressure (0 vs. 27%).

The estimates also differed on the prevalence of metabolic syndrome among Mexican-American adolescents. The MetS. definition identified metabolic syndrome in 7.8% of Mexican-American adolescents compared to only 4.1% by the NCEP MetS. definition. This was an insignificant percentage of Mexican-American adolescents possessing metabolic syndrome compared to non-Latino adolescents when using the NCEP MetS. definition compared to the significant association found when using the NCEP MetS. definition. Despite these differences, the results pertaining to the association of acculturation with metabolic syndrome using either definition showed a statistically insignificant association in a logistic model.

CHAPTER 5

DISCUSSION AND POLICY RELEVANCE

This study examined three specific aims that addressed the prevalence of metabolic syndrome among Mexican-American adolescents. Results presented thus far have simply addressed the research questions and have not been couched in a broader context. This chapter will interpret the results in relation to previously published research and relevant policy implications.

5.1 Aim 1: Examine the prevalence of metabolic syndrome, physical activity, dietary intake, and overweight between Mexican Americans and non-Latinos

5.1.1 Prevalence of Metabolic Syndrome among U.S. Adolescents

This study used data from NHANES 1999-2002 and found the prevalence of metabolic syndrome to be 4.8% or 1,519,312 cases. Previous research using data from NHANES III 1988-1994, estimated the prevalence of metabolic syndrome to be 4.2%, representing 910,000 affected adolescents (Cook, Weitzman, Auinger, Nguyen, & Dietz, 2003). These results show that metabolic syndrome is becoming more prevalent among U.S. adolescents with an increase of approximately 14% percent or slightly more than 600,000 new cases of metabolic syndrome occurring among U.S. adolescents from 1994-2002.

Metabolic syndrome is important because it has been implicated as a risk factor for type-2 diabetes and cardiovascular disease. Some studies have also shown that metabolic syndrome poses a larger risk for developing type-2 diabetes compared to cardiovascular disease (Sattar et al., 2003; Wilson, D'Agostino, Parise, Sullivan, & Meigs, 2005). The distribution of metabolic syndrome traits found among adolescents with metabolic syndrome in this study seems to support this association. Abdominal adiposity was the most prevalent (~45%) of the five metabolic syndrome traits and fasting plasma glucose (30%) was the second most prevalent trait among adolescents with metabolic syndrome. Research shows that overweight, especially abdominal adiposity, and elevated blood glucose levels are highly predictive of type-2 diabetes (Cook, Weitzman, Auinger, Nguyen, & Dietz, 2003; Freedman, Dietz, Srinivasan, & Berenson, 1999). Thus, adolescents with metabolic syndrome seem to be at risk for developing type-2 diabetes.

Several demographic and behavioral characteristics were also found to be associated with having metabolic syndrome. Bivariate analysis showed that the prevalence of metabolic syndrome was found to be higher in adolescent males compared to females, those that had a sedentary life versus those who were physically active, and in individuals with a lower number of foods in their diet compared to those with a higher number of foods in their diet. Overweight was also a major risk factor predisposing adolescents to develop metabolic syndrome. One-quarter of adolescents with metabolic syndrome had a BMI score greater than or equal to the 95^{th} percentile, which classifies them as overweight. Overweight was also found to increase the probability of all the metabolic syndrome traits. This represents the strongest association with a greater prevalence of metabolic syndrome in adolescents.

Bivariate analysis also found that Mexican-American adolescents had the highest prevalence of metabolic syndrome compared to Caucasians and African Americans. Compared to NHANES III prevalence estimates, this study estimated a 39% increase in the prevalence of metabolic syndrome among Mexican-American adolescents (5.6% to 7.8%). African-American adolescents (2% to 3%) had a 50% increase, but still had a much lower overall prevalence compared to Mexican-American adolescents. The prevalence of metabolic syndrome among Caucasian adolescents (4.8% to 5%) remained virtually unchanged with an increase of 4%. It is alarming that Mexican-American adolescents are experiencing such rapid increases in the cases of metabolic syndrome while the prevalence among Caucasians is virtually static.

It is important to understand how cultural factors contribute to the development of metabolic syndrome in Mexican-American adolescents and how other factors related to ethnicity, such as overweight and physical activity, account for the higher prevalence and rapid increase of metabolic syndrome in Mexican Americans. The findings of this study indicate that Mexican American ethnicity or culture has a potentially protective effect against the development of metabolic syndrome. This conclusion is consistent with literature that has suggested that Latino culture, including Mexican American culture, in the U.S. seems to have a protective role with respect to certain adverse health outcomes (Epstein, Botvin, & Diaz, 2001; Fraser, Piacentini, Van Rossem, Hien, & Rotheram-Borus, 1998; C. P. Kaplan, Erickson, & Juarez-Reyes, 2002; Mazur, Marquis, & Jensen, 2003; Rasmussen, Negy, Carlson, & Burns, 1997; Samaniego & Gonzales, 1999). Further, if Mexican American ethnicity is not the reason that Mexican-American adolescents have a higher prevalence of metabolic syndrome, then other behavioral factors are probably responsible for the higher prevalence of metabolic syndrome among Mexican-American adolescents.

5.1.2 Variations in Physical Activity, Diet, and Overweight

In an effort to explain the elevated likelihood of having metabolic syndrome in Mexican Americans, analyses were conducted to determine if there were differences between Mexican Americans and Caucasians with respect to physical activity, dietary intake, and overweight. Any differences found would be telling because of the relatively low and unchanged prevalence of metabolic syndrome in Caucasian adolescents versus the high and rapidly increasing prevalence of metabolic syndrome among Mexican-American adolescents.

Multivariate analysis showed that Mexican Americans were significantly more likely to be inactive and overweight compared with Caucasian adolescents. This difference may begin to explain the higher prevalence and increasing incidence of metabolic syndrome among Mexican-American adolescents. This study, along with previous research, indicates that overweight is a strong risk factor for metabolic syndrome in adolescents (Cook, Weitzman, Auinger, Nguyen, & Dietz, 2003). Other research has shown that inactivity is associated with overweight (Coleman et al., 2005). The finding that Mexican-American adolescents are more inactive compared to Caucasians suggests a greater chance for adolescent overweight and a resulting increased risk for metabolic syndrome in Mexican-American adolescents.

These findings seem to agree with the notion that overweight does not cause the development of metabolic syndrome, but rather acts in conjunction with other factors, such as a lack of physical activity (Grundy, 2004). It was also found that among Mexican Americans; males were more likely to be overweight compared to Mexican-American females. This indicates that the greater prevalence of metabolic syndrome among adult men compared to women begins in adolescence for those of Mexican-American ethnicity.

Mexican-American adolescents were also found to have a lower intake of calories, carbohydrates, and saturated fat, indicating a healthier diet compared to Caucasian adolescents. This contrasts the findings above because the dietary intake of Mexican-American adolescents does not seem to agree with the higher prevalence of overweight and metabolic syndrome found in this group. Multivariate analysis did not find a significant association between dietary intake and metabolic syndrome, but associations to several of the metabolic syndrome traits were found. This suggests that the dietary pattern above could indicate that dietary intake is less of a risk factor for the development of metabolic syndrome among Mexican-American adolescents compared to Caucasian adolescents.

5.1.3 Policy Implications and Recommendations

Aim 1-Recommendation 1: Improved access to comprehensive preventive care for adolescents, especially Mexican-American adolescents should be sought. This includes identifying organizational factors that currently serve as barriers to providing these services equitably.

Most causes of adolescent morbidity and mortality are preventable, including metabolic syndrome. This study found that Mexican-American adolescents have the highest prevalence and one of the most rapidly increasing incidence of metabolic syndrome across racial and ethnic categories. Mexican Americans also have higher rates of childhood overweight and a sedentary lifestyle compared to Caucasians. These findings suggest that Mexican-American adolescents will continue to have increased morbidity compared to

Caucasians unless something is done. One way of helping to curb the morbidity associated with the conditions above is to ensure that Mexican-American adolescents have equal access and opportunity to receive preventive health care services. These services could serve as an early intervention to prevent the onset of childhood overweight and a sedentary lifestyle, which can cause the development of metabolic syndrome and other conditions.

Health care providers are in a unique position to use clinic encounters with adolescents to detect risky behavior or disease early on and to offer health guidance in addition to what is provided in a school-based setting (Elster, 2006). Guidelines for children's and adolescent's preventive services have been developed by several national organizations: United States Preventive Services Task Force (USPSTF), American Medical Association (AMA), American Academy of Family Physicians (AAFP), United States Public Health Services from the Maternal and Child Health Bureau (MCHB), and the American Academy of Pediatrics (AAP) (American Academy of Family Physicians, 1994; American Academy of Pediatrics, 1995; Elster & Kuznets, 1992; National Center for Education in Maternal and Child Health, 1994; U.S. Preventive Services Task Force, 1996).

Comparing these recommendations can be difficult because some use exclusively evidence based methods while others also incorporate expert opinion (Elster, 2006). The guidelines above, while not identical, seem to agree that clinical services should include screening and counseling for future cardiovascular disease including management of overweight and early treatment of hypertension and hyperlipidemia (i.e., elevated triglycerides, cholesterol etc), which are part of metabolic syndrome. There is less agreement as to the frequency that preventive health care visits should occur (Elster, 1998).

Other organizations, such as the Society for Adolescent Medicine and the AMA's GAPS framework recommend comprehensive guidelines for adolescent health, which include screening, anticipatory guidance, and immunizations (Elster & Kuznets, 1992; Rosen, Elster, Hedberg, & Paperny, 1997). Anticipatory guidance also includes a parental component to help parents adapt and make decisions about their adolescent's changing health needs (Elster, 1998). This parental component is critical because adolescent behavior and health outcomes have been shown to be affected by parental attitudes and involvement (DiClemente et al., 2001; Resnick, Bearman, & Blum, 1997). Comprehensive guidelines advocate screening adolescents for hypertension, overweight, and hyperlipidemia when indicated, which are all associated with metabolic syndrome (Elster, 2006). Through anticipatory guidance, providers can provide adolescents with counseling to develop or maintain a healthy diet, safe weight management practices, and performing regular physical activity. It is important to note the guidelines for adolescent health described above already include regular screening for many of the traits associated with metabolic syndrome. It would not be difficult for the AMA and other agencies to expand the guidelines to explicitly include metabolic syndrome as a clinical condition to screen for so as to facilitate earlier intervention and limit the potential development of metabolic syndrome.

Despite these guidelines advocating that health care providers take a proactive role in counseling adolescents, many do not know how. Many health care providers were trained to manage biological causes of disease and may not be prepared to manage preventable conditions primarily caused by personal choices and behaviors, such as metabolic syndrome (Elster, 2006). As a consequence of this biological focus many health care providers fail to address behaviors and instead primarily focus on biological diseases or conditions (Blum, Beuhring, Wunderlich, & Resnick, 1996; Goodwin, Flocke, & Borawski, 1999). Ensuring good preventive counseling is especially important for Mexican-American adolescents that have a rapidly increasing prevalence of metabolic syndrome, but may not have adequate access to health care. Thus, making optimal use of the time a provider does see a Mexican-American adolescent is paramount.

5.2 Aim 2: Examine if Physical Activity and Dietary Measures are Associated with Metabolic Syndrome

Differences in physical activity and diet were found between Mexican Americans and Caucasians. Determining the significance of this finding may be facilitated by understanding the independent association of physical activity and diet on metabolic syndrome. Adolescents who did not engage in any physical activity were found to have a higher probability of having metabolic syndrome independent of race and ethnicity, gender, age, BMI, and total energy intake. Given the same controls inactive adolescents were also more likely to have elevated blood pressure. This study is the first to empirically link inactivity with an increased probability of having metabolic syndrome in adolescents. These results indicate that inactivity could be a driving force contributing to the high prevalence of metabolic syndrome found in Mexican-American adolescents. A higher probability of having higher blood pressure not only contributes to metabolic syndrome, but puts Mexican-American adolescents at higher risk for cardiovascular disease later in life.

A significant association between dietary intake and metabolic syndrome was not found in this study, which seems to contradict the hypothesis that a less healthy diet would contribute to the likelihood of having metabolic syndrome. Bivariate analysis showed that those with a low number of foods in their diet had a significantly higher prevalence of metabolic syndrome, but on multivariate analysis this association did not hold after controlling for race and ethnicity, age, gender, physical activity and BMI. BMI and physical inactivity had significant associations with metabolic syndrome in these models. These findings seem to reiterate the importance of overweight and inactivity as risk factors for metabolic syndrome in adolescents.

Although diet was not found to be directly associated with metabolic syndrome several of the dietary measures were found to be significantly associated with some of the metabolic syndrome traits. For instance, an increased probability of elevated triglycerides and lower HDL were associated with dietary intake. The probability of abdominal adiposity also increased with an increased frequency of eating meals outside the home. These results demonstrate that intake of any particular macronutrient is not sufficient to increase the probability of having metabolic syndrome. However, this study did not test whether the probability of having metabolic syndrome was higher given increases in several dietary measures simultaneously or due to specific foods eaten.

5.2.1 Policy Implications and Recommendations

Aim 2-Recommendation 1: Efforts to increase adolescent physical activity should be undertaken in an effort to reduce the likelihood of developing metabolic syndrome. School-based programs have the potential to educate and reach the most number of adolescents so this critical component should not be ignored when addressing low physical activity levels among adolescents.

According to the Youth Risk Behavior Survey (YRBS) dramatic declines in physical activity occur during adolescence and almost a quarter of males and almost 40% of female adolescents were classified as inactive in 2001 (Brownson, Boehmer, & Luke, 2005; Leslie, Sparling, & Owen, 2001; Stone, McKenzie, Welk, & Booth, 1998). One explanation for the high rates of physical inactivity and the reduction of physical activity during adolescence is the decreasing number of students attending daily physical education class. According to the CDC, from 1991-1995 the rate of high school students participating in daily physical education class dropped from 42% to 25%. Even among those attending physical education classes only 39% were actually physically active. A significant linear decline was noted among Latino students from 1991-2003 (CDC, 2004c). These findings are consistent with the results of this study showing Mexican-American adolescents to be less physically active compared to Caucasian adolescents.

Physical activity among children and adolescents has also been found to be affected by perceptions of personal barriers. These perceived barriers can be influenced by the stress, threats to self-esteem, reduced social support, and increased risk factors for a variety of health conditions associated with the transition from elementary school to high school and from high school to college (Garcia, Pender, Antonakos, & Ronis, 1998; Gyurcsik, Spink, Bray, Chad, & Kwan, 2006; Stone, McKenzie, Welk, & Booth, 1998). According to Gyurcsik and colleagues the perceived barriers to physical activity increase as children and adolescents increase their grade level. In high school and lower grades the primary reason for not performing physical activity seems to be related to external restrictions (e.g. lack of transportation, no teams to join) or a interpersonal barrier (e.g., intimidation, lack of skill, support from family and friends) surrounding physical activity, but for college freshman the most prominent reasons were social commitments to friends or family or lack of motivation (Gyurcsik, Spink, Bray, Chad, & Kwan, 2006).

Given that physical inactivity was found to be significantly associated with a greater probability of having metabolic syndrome it suggests that some physical activity could decrease the probability of developing metabolic syndrome. This is supported by the finding that Caucasians had a higher rate of physical activity and less healthy dietary intake compared to Mexican-Americans. Despite this, Mexican-American adolescents still had a much higher rate of metabolic syndrome and a larger increase in the number of cases over the last several years. Based on this it seems that a lack of physical activity may play a greater role in an increased probability of developing metabolic syndrome compared to dietary intake. Physical activity has also been linked to childhood overweight. Consistent with this, Mexican Americans had a greater likelihood of being inactive and they also showed a larger percentage of overweight adolescents compared to Caucasians. Given these associations it is plausible that if Mexican-Americans engaged in physical activity as often as Caucasians they would probably have a lower prevalence of metabolic syndrome as well as childhood overweight.

Aim 2-Recommendation 2: Further research is needed to gain a better understanding of the association between diet and metabolic syndrome. Researchers should focus on specific foods (e.g., fruits, meats, etc.) instead of macronutrient intake.

This study was able to show an association between the number of foods eaten and macronutrient intake with metabolic syndrome or some of its traits. This is helpful in understanding how diet may affect the risk of metabolic syndrome, but it is difficult to make clear programmatic recommendations from these findings. There has been extensive coverage in the media about studies or fad diets highlighting elevated intake of macronutrients (e.g., carbohydrates or fat) and their association with disease and weight gain. It is less clear how effective these types of messages are received by the public compared to guidelines or recommendations that focus on specific food intake (e.g., fruits, vegetables, whole grains, etc.) Studying the association of diet on metabolic syndrome using the types of foods eaten versus the macronutrient intake may help lend a different perspective on how diet is associated with metabolic syndrome and make more direct programmatic recommendations. This approach also seems to be more consistent with the dietary messages being given to adolescents from sources such as the USDA food pyramid and school-based instruction.

Several factors should be considered when conducting this research. The types of foods that are available, nutritional information at school, and promotion of good nutrition at home have been shown to affect the food choices made by children and adolescents at school (Institute of Medicine, 2005; US Department of Health and Human Services, 2000). This is important to understand because the school environment has been shown to play a critical role in shaping eating habits (American Academy of Pediatrics, 2004b; Institute of Medicine, 2005; Wechsler, McKenna, Lee, & Dietz, 2004). The role that school plays in shaping eating habits can be similar or in contrast to the eating habits at home. For Mexican-American adolescents the foods served in American schools may not be similar to those served at home. This may make it difficult for Mexican-American adolescents to accept the nutritional information provided in schools if it is not reinforced at home.

5.3 Aim 3: Explore the Association of Acculturation with Metabolic Syndrome, Physical Activity, and Diet

In general, acculturation is a process predominantly found in first generation immigrants. Non-immigrants from various racial and ethnic backgrounds do not typically face its challenges or stresses. The multidimensional view allows for acculturation to the dominant culture and retention of the non-dominant culture to occur independently allowing for the possibility that both cultures could change (Zane & Mak, 2003). However, second and even third generations may still be going through the process of acculturation in some form. Time in the U.S. is partly responsible for the acculturation experience of first generation immigrants as are socio-economic factors, such as the concentration of Latinos in the community or parental educational attainment. For second and third generation Mexican-American adolescents the acculturation status of their parents is probably the largest factor affecting the extent to which they will need to acculturate. The concentration of other Latinos leading more traditional lifestyles would also affect the acculturation of second and third generation children and adolescents.

5.3.1 Acculturation and Metabolic Syndrome

A direct association between acculturation and metabolic syndrome was not found. There are several reasons why this might be the case. First, the acculturation variable is measuring a complex process. How this variable is operationalized may be important in determining its association with other variables. Although many researchers agree on what the definitions of acculturation there is a lack of agreement on how to most effectively measure this multifaceted concept. Without a standard way of measuring acculturation, it may be difficult to detect certain associations. It also makes comparing studies with differing measures of acculturation difficult.

In this study acculturation was measured by the primary language used. While multiple researchers have advocated primary language use as a reliable way of measuring acculturation others have advocated using time in the U.S. as an exclusive measure of acculturation (Becerra, Hogue, Atrash, & Perez, 1991; Cuellar, Arnold, & Maldonado, 1995). The rationale for the latter is that acculturation is generally thought of as a time sensitive process. Those who are in contact with the dominant culture longer are likely to be more acculturated because of a desire to fit in or as a means to meet their basic needs (e.g., employment or health care). Thus, time in U.S. may be an important factor unable to be included in the measurement of acculturation in this study.

One can make the argument that using primary language to measure acculturation implicitly incorporates time in the U.S. because it takes an average person time to learn a new language. This may be particularly true for children and adolescents who are constantly exposed to American culture in school, through the media, or in their social networks. As a person spends more time in the U.S. and becomes more comfortable with their English skills they may be more likely to interact with the English speaking dominant culture more frequently. This exposure may aid adoption of certain characteristics prevalent in the dominant culture and facilitate acculturation.

5.3.2 Acculturation, Physical Activity, Diet, and Overweight

The lack of a measurable association between acculturation and metabolic syndrome in this study does not necessarily suggest that acculturation should be discounted. Due to the complex nature of the acculturation process, it is possible that changes take place as a result of acculturation (e.g., language use or lifestyle) that could have a direct bearing on health outcomes, like metabolic syndrome. This would create a condition in which acculturation may indirectly influence the probability of developing metabolic syndrome. For example, physical activity and dietary habits have been linked to several factors predisposing adolescents to metabolic syndrome, type-2 diabetes, and overweight (NCEP, 2002).

In this study, Mexican-American adolescents with higher levels of acculturation were found to be more likely to be active. On average, more acculturated Mexican Americans reported a greater number, frequency, and duration of physical activity performed during the last month. These results indicate that performing physical activity may become easier (i.e. fewer perceived barriers) or more desirable as Mexican-American adolescents acculturate, which is contrary to the original hypothesis that more acculturated adolescents would perform less physical activity. It appears that as acculturation increases, access to physical activity opportunities may increase due to the increased comfort with American culture that higher levels of acculturation afford. This may occur by joining school-based teams, community-based leagues, or more acculturated adolescents may be more comfortable negotiating participation in informal activities like neighborhood pick-up games. Higher levels of acculturation may also facilitate transportation to public parks or other recreational facilities by helping adolescents negotiate the use of public transport. All of these possibilities are based on the Mexican-American adolescent having more contact with non-Latinos or perhaps other more highly acculturated Latinos.

What is important is that results indicate that increased physical activity lowers the probability of developing metabolic syndrome. At first glance these last findings seem to contradict that Mexican-American adolescents are associated with a higher prevalence of metabolic syndrome. On closer inspection, while higher levels of acculturation have a positive influence on the physical activity profile of Mexican-American adolescents they do not seem sufficient to override the racial and ethnic gap in the performance of physical activity. Comparisons between groups show that Mexican Americans compared to non-Latinos are more likely to be inactive, perform fewer types of activities, with less frequency, and less duration. This suggests that Mexican Americans may face greater obstacles in finding opportunities to perform physical activity compared to non-Latino groups if they have a low level of acculturation.

In addition to increased physical activity, higher levels of acculturation were also associated with higher daily intakes of several macronutrients as well an increase in the number of times meals were eaten at restaurants. The increase in restaurant meals eaten and the foods eaten elsewhere may have contributed to the approximately 137 extra kcal per day consumed by Mexican-American adolescents with higher levels of acculturation compared to adolescents with lower levels of acculturation. This may be a key finding in explaining the greater prevalence of childhood overweight found among those with higher levels of acculturation because for every 10 kcal consumed per day that are not used, it is the equivalent of gaining one pound per year (Nielsen & Popkin, 2003). Thus, if these extra calories are not used (e.g., during physical activity) this could potentially translate into a yearly weight gain of almost 14 pounds, on average.

These results are indicative of a shift in dietary pattern among Mexican-American adolescents as they become more acculturated, from healthy to less healthy. It is possible they are switching from foods that are considered a part of a traditional Mexican diet (e.g., corn tortillas) because of a lack of availability of the foods they are used to eating. This may occur because certain American foods can be more affordable and accessible (e.g., fast food, sodas etc.). It is also plausible that the food portions that Mexican-American adolescents eat are increasing as they become more acculturated. This assertion is partially supported by the finding above that the number of times Mexican-American adolescents ate restaurant food per week and total calorie intake increased as their level of acculturation increased. As well as research has demonstrating that food prepared outside the home is higher in fat and portions are usually larger than those prepared at home (Popkin, Duffey, & Gordon-Larsen, 2005). The findings above also serve to support the second recommendation from aim 2 of this study, which recommends that individual foods should be examined in an effort to better understand the relationship of diet and metabolic syndrome.

5.3.3 Policy Implications and Recommendations

Aim 3- Recommendation 1: An agreed upon multidimensional analytic definition of acculturation should be established. This would facilitate the comparison of research findings and help to solidify our understanding of how acculturation is associated with metabolic syndrome and other conditions.

The lack of a standardized measure of acculturation is one of the most difficult problems that need to be addressed in Latino health research. There are myriad studies that have used acculturation as a measure in an attempt to understand a variety of health or sociological questions; however, building on the results of these studies is problematic because of the variety of ways in which acculturation has been operationalized. There are several levels to this problem. First, some have used unidimentional definitions and others have used multidimensional definitions. Many agree that a multidimensional approach is preferred, but the main obstacle to using a multidimensional acculturation measure is that primary data collection must almost certainly be used. There are no large nationally representative datasets that allow for the use of a multidimensional acculturation measure in a secondary data analysis.

Latinos in the U.S. are a heterogeneous population comprised of people from approximately 26 countries. There are many similarities between these individuals, but it is also important to realize that there are also differences. Many U.S. Latinos do share some common cultural traits, such as *familismo*, *confianza*, *colectivismo*, and others. Language use can differ because of regional influences pertaining to the use of certain adjectives and nouns, while social class can influence not only language, but lifestyle as well. These similarities and differences can affect social interactions. This leads to the second problem with acculturation scales, which is determining whether a scale can be successfully created for use among any of the Latino subgroups or if the scale needs to be subgroup specific. There are acculturation scales which assume both of these positions, but as with the first issue there is no consensus as to which is more appropriate.

The last issue with acculturation scales is the lack of agreement of how to incorporate certain measures into an acculturation scale. For example, if the scale measures language should there be questions solely about language use or should language preferences also be included? Should language questions be asked in a general context or should they be asked with specific contexts in mind (e.g., among friends or family)? These questions extend beyond language and also pertain to other socio-cultural measures employed by a variety of acculturation scales. In summary, a multidimensional consensus measure of acculturation would help to make studies more comparable, but also facilitate the incorporation of acculturation into large datasets to improve analytic options.

Aim 3-Recommendation 2: Understanding how the built environment affects acculturation and can be used to improve physical activity and dietary patterns in Mexican-American adolescents.

Results show that physical activity is directly associated with metabolic syndrome and diet seems to be associated with various metabolic syndrome traits. The built environment is important to take into account when considering how to address physical activity and diet among adolescents because it has been linked to both physical activity and diet. It is especially important in Mexican-American adolescents because the built environment can affect social interactions and possibly influence the rate of acculturation, which this study found to be associated with physical activity and dietary intake.

The built environment is usually thought of as a multifaceted concept including urban design (e.g., city design and physical elements), land use (e.g., density of residential or commercial properties), transportation systems, and infrastructure (e.g., roads, sidewalks, or paths) (Handy, Boarnet, Ewing, & Killingsworth, 2002; Popkin, Duffey, & Gordon-Larsen, 2005). It has been found to restrict or promote physical activity by affecting recreational safety, access to recreational facilities, or transportation options (Popkin, Duffey, & Gordon-Larsen, 2005). Opportunities to exercise, access to recreational facilities determined by the built environment or perceptions of the built environment have been consistent predictors of physical activity in children and adolescents (Popkin, Duffey, & Gordon-Larsen, 2005; J. F.

Sallis, Prochaska, & Taylor, 2000). As discussed previously, lower levels of acculturation may be associated with increased perceived barriers. This may begin to explain why lower levels of acculturation are associated with less physical activity and highlights the importance of considering the built environment when attempting to improve physical activity among Mexican-American adolescents.

While schools play a major part in the nutritional attainment of children and adolescents the built environment can also influence dietary patterns. The accessibility of fast food restaurants and the frequency of eating meals outside the home have been increasing (Jekanowski, 2001; Popkin, Duffey, & Gordon-Larsen, 2005). Eating meals outside the home have been associated with decreased nutrient intake and diet quality while BMI and total energy intake have been found to increase (Ebbeling et al., 2004; French, Story, Neumark-Sztainer, Fulkerson, & Hannan, 2001; Popkin, Duffey, & Gordon-Larsen, 2005; Thompson, Ballew, Resnicou, Must, & Bandini, 2004). This is consistent with the finding present earlier that more acculturated Mexican-American adolescents ate out more often and had increased dietary intake of calories, carbohydrates and saturated fat compared to their counterparts with lower acculturation.

5.4 Justification for a Pediatric Definition of Metabolic Syndrome

The sensitivity analysis examining the NCEP definition (NCEP MetS.) and the modified pediatric definition (MetS.) found significant differences between the prevalence of metabolic syndrome among U.S. adolescents and also among Mexican-American adolescents. These differences can be explained by the classification of fewer adolescents with four of the five metabolic syndrome traits using the NCEP MetS. definition compared to the MetS. definition.

The two definitions share the same five traits used to define metabolic syndrome, but the threshold values between the NCEP MetS. definition and the pediatric MetS. definition differ in most cases. The three largest differences are in the cut-points for elevated triglycerides, abdominal adiposity, and elevated blood pressure. In order to have elevated triglycerides in the adult NCEP definition an individual must have a triglyceride level of 150 mg/dl or higher compared to the pediatric definition where the cut-point is greater than or equal to 110 mg/dl. Abdominal adiposity (measured by waist circumference) and elevated blood pressure in adolescents do not have static cut-points because adolescents are still going through puberty. In adolescents both of these measures are dependent on age and gender. Blood pressure measurements are also dependent on height, in addition to age and gender. Therefore, adolescent cut-points for abdominal overweight and elevated blood pressure are determined by percentile values based on growth charts produced by CDC.

The adult definition of abdominal overweight is greater than 102 cm for males and 88 cm for females compared to the adolescent cut-point of the 90^{th} percentile for age and gender. In the NCEP MetS. definition high blood pressure (≥ 135/82 mm/Hg) is needed and in the MetS. definition the 90^{th} percentile by age, gender, and height is required. These differences between the NCEP MetS. and the MetS. definitions could be the cause of the differences found in the sensitivity analysis. It is evident that in an adolescent whose body is still growing, fewer will meet the adult criteria for metabolic syndrome compared to the MetS. definition that takes into consideration the immature adolescent body to set cut-points.

Based on these findings it is not recommended that the NCEP MetS. definition for metabolic syndrome be used to assess metabolic syndrome in adolescents. Instead, a modified definition that takes into account the changes that an adolescent's body is undergoing should be used to identify metabolic syndrome in the pediatric population. Adolescents that meet the adult NCEP definition for metabolic syndrome most likely have the highest risk for developing metabolic syndrome because the adult cut-points are well above what is considered normal for adolescents and in most cases also higher than what is required to classify an adolescent with a particular metabolic syndrome trait under the MetS. definition.

5.5 Conclusion

This study has shown that the overall prevalence of metabolic syndrome in adolescents increased from 1994-2002 and identified Mexican-American adolescents as the most at risk group for developing metabolic syndrome. Among all groups, overweight and inactivity were associated with a higher prevalence of metabolic syndrome. Among Mexican Americans, acculturation did not have a direct effect on the prevalence of metabolic syndrome, but it did have an indirect association with physical activity and some dietary intake measures.

The process of acculturation is dynamic and influences a complex array of factors in a Mexican-American adolescent's life that can affect their health outcomes. It is important to consider the Mexican-American adolescent's family, community, school, behaviors, and access to and utilization of health care services in order to fully explore their risk for metabolic syndrome as adolescents and into adulthood. Research needs to be performed to further our understanding of these complex interactions in an effort to develop interventions or policies that can address the current and growing health care needs of Mexican Americans and other Latino sub-groups.

With the growing number of Latinos in the U.S., organized political involvement may increase and policy makers may be more likely to pay closer attention to the needs and wants of this population. In addition, the media is providing the general public with an increased amount of information regarding the epidemic of overweight/obesity, type-2 diabetes, and cardiovascular disease, which are all associated in one form or another with metabolic syndrome. The public’s greater awareness of these health conditions could prompt more pressure on local, state, and national policy makers to take action that will reduce the burden of these conditions.

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